THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 61 Thursday, September 7, 1939 No 1203

PUBLISHED WEEKLY

Subscription Terms : 17s. 6d. per annum.
Foreign and Colonial : 20s. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL

3, Amersham Road, HIGH WYCOMBE, Bucks.

Telegraphic Address : "Zacatecas, High Wycombe."

Telephone : HIGH WYCOMBE 1792 (3 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT : 1938-39

W. B. Lake, J.P., Lake and Elliot, Limited, Braintree, Essex.

LIST OF SECRETARIES—

General Secretary : T. Makemson, Saint John Street Chambers, Deansgate, Manchester, 3. London Office : 49, Wellington Street, London, W.C.2.

Birmingham, Coventry and West Midlands : A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham, 3.

East Midlands : B. Gale, "Parkdale," Boulton Lane, Alvaston, Derby.

Lancashire (*pro tem*) : A. Boyes, 377, Liverpool Road, Patricroft, Manchester.

London : G. W. Daglish, Stewarts & Lloyds, Limited, Winchester House, Old Broad Street, E.C.2

Middlesbrough : G. P. Kirk, North-Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees.

Newcastle-upon-Tyne : C. Lashly, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead-on-Tyne.

Scottish : J. Bell, 60, St. Enoch Square, Glasgow.

Sheffield : T. R. Walker, M.A., F.I.C., 11, Broomgrove Crescent, Sheffield, 10.

Wales and Monmouth : J. J. McClelland, 12, Clifton Place, Newport, Mon.

West Riding of Yorkshire : S. W. Wise, 110, Pullan Avenue, Ecclesshill, Bradford.

South Africa : F. C. Williams, Mutual Buildings, Corner of Harrison and Commissioner Streets

Bristol : A. Hares, Park Crescent, 648, Stapleton Road, Bristol, 5.

Burnley : H. Buckley, Ellsmere, Norfolk Avenue, Burnley, Lancs.

East Anglian : J. L. Francis, 12, Glenhurst Avenue, Colchester Road Ipswich.

Falkirk : T. R. Goodwin, "Viewfield," Falkirk Road, Bonnybridge, Scotland.

Lincoln : E. R. Walter, M.Sc., The Technical College, Lincoln.

The Institute of Vitreous Enamellers

President : Sir Harold Hartley, F.R.S., Euston Station, London, W.C.1.

Chairman : W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.

Hon. Secretary : Miss E. Christine Elliot, 49, Wellington Street, Strand, London, W.C.2.

Foundry Trades' Equipment and Supplies Association

President : G. E. France, August's Limited, Thorn Tree Works, Halifax.

Secretary : K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President : W. E. Clement, Morfa Foundry, New Dock, Llanelly.

Secretary : J. D. D. Davis, 9, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are :—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone : Colmore 4274-4275 Telegrams : CIRA
The B.C.I.R.A. Scottish Laboratories are :—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone : 332

Contents

	PAGE
War!	163
Book Review	164
Materials and Their Testing	164
Decarburisation of Granulated Pig-Iron	164
Foundry Exhibition Postponed	164
Changes of Addresses	164
Random Shots	164
General Principles Applicable to the Compounding of Alloys by Melting	165
Publications Received	168
Producing a Large Iron Casting by the Randup on Process	169
The Iscor Works in 1938	170
Mill Room Practice	172
Power and Electrode Consumption in Electric Furnaces	174
The Week's News in Brief	176
Trade Talk	176
Personal	176
Contracts Open	176
New Companies	176
Raw Material Markets	178

War!

Few of those who from 1914 to 1918 served their country in any of the fighting services or in the making of munitions ever dreamt that after but a little more than two decades they would again have to respond to the call to "do their bit." The great difference between 1914 and 1939, however, is the astounding preparedness which is everywhere exhibited, especially by industry. The chaos shown at the inception of the last war resulted in a large number of square pegs being "fitted" into round holes. Experienced metallurgists and highly-qualified skilled men were being rapidly absorbed into the rank and file of the fighting services, whilst industry had to content itself with the residue. A very few firms were engaged on armaments and they were fairly leisurely carrying out the highest grade of work to obsolete specifications. For instance, only acid steel could be accepted for shell making! Later in the war even cast iron invaded this field. The war had certainly been in progress several years before production really began to make itself felt. Naturally there was some shortage of raw materials which involved their use to best advantage of the State, but in no case that we know of was recourse had to really *ersatz* substitutes. Rationing of raw materials was effected by a system, largely devised by Sir William Larke, of issuing priority certificates—the priority beng assocated with urgency and importance. If our memory serves us correctly Mr. Ernest Wells was director of steel castings production and Mr. John Shaw for iron castings. Whoever undertakes these tasks for the war of 1939— will find his task much easier as these two sections of the industry have never been better organised. Technically the industry is splendidly equipped, as many hundreds of thousands of pounds' worth of new plant has been installed during the last decade. The British Cast Iron Research Association will now place its organisation at the service of the whole of the industry regardless of membership, as reliance can be placed on the recipients of help reciprocating in the future. The Institute of British Foundrymen is also co-operating with the Government in the proper utilisation of the technical personnel of the industry. Most of its members have offered their services to the Government to be utilised where the authorities think best. Whether it will be possible to organise a series of autumn and spring meetings is not yet known, as "technically" such assemblies may enter the classification of amusements or sporting gatherings! In the last few years, Germany has not been marking time, and statistically they are in a position to maintain heavy outputs, but that country starts with the disadvantage of shortages in many directions. It is a fact that their present supply of munitions has been largely built up on *ersatz* material, and the testing time for their worth has now arrived. Ever since the Nazis came into power there has been—at least in the field of the metallurgy of cast metals—a pronounced decline in the calibre of research work. The object sought was ever the same—national economy. In practice this meant a search for the minimum amount of the more expensive or imported materials which would suffice. Moreover, ridiculous attacks have been made on patented or proprietary processes of foreign origin as the taking out of licences would naturally involve the export of their all too precious stocks of foreign currency. Even the proportions of runners and risers have been standardised at a minimum. Already, as we publish elsewhere, a control has been set up to deal with price levels, to include castings, and most of the raw materials. At the moment the general level of the prices is unchanged. Some changes in existing prices of non-ferrous metals are expected, for as they mainly refer to imports, there is the added cost of war-risk insurance on future deliveries. Speaking for the whole of the foundry industry which we know so well, we can assure His Majesty's Government that all foundrymen from the directors down to the youngest apprentice moulder fully approve of the actions which have been taken to rid Europe of this canker of Hitlerism. Like the Government, the Institute of British Foundrymen has done its best to promote international goodwill. By the organisation of and participation in annual technical congresses, its members have endeavoured to show to the Germans that if they wished to enjoy the social and economic conditions under which we live, they have merely to weed their own garden, for, as a Paris correspondent of a London newspaper recently summed up the situation—one cannot keep one's own garden in order, if the man next door neglects his.

Book Review

Blast-Furnace Practice. By Ralph H. Sweetser. Published by the McGraw-Hill Publishing Company, Limited, Aldwych House, London, W.C.2. Price 24s.

This book relates primarily to American practice, and is none the worse thereby, because that country has for some years held the premier place in the realms of design and production. The author has produced a work which will be appreciated by the ordinary works metallurgist who still admires orthodoxy. It must be realised that in this country great use is made of lean ores, whereas in America the reverse is true. Moreover, there are other differences and notes on desulphurisation in a modern European book would be quite different, as no doubt the soda-ash process would be described. The six chapters carry the obvious headings, except perhaps the last, which deals with the commercial side of blast-furnace practice. This is very interesting, and the figures are worth comparing with conditions on this side, which are so very different. It is stated this work should be useful as a reference book for students, and with this the reviewer agrees, for it makes no pretensions to being a text-book. For those already versed in the subject it makes interesting reading.

Materials and Their Testing

A general discussion on "The Properties and Testing of Heat-Insulating Materials," organised by the Joint Committee on Materials and their Testing, in conjunction with the Institution of Gas Engineers, will be held in London on November 23 next. The sub-divisions of the subject and the names of the authors who are contributing Papers are as follow :—(1) "High-temperature Insulating Material," by Dr. J. B. Austin, United States Steel Corporation (United States). (2) "Low-temperature Insulating Material," by Dr. Ezer Griffiths, F.R.S., National Physical Laboratory (Great Britain); a Paper from an authority in the United States. (3) "Insulation of Buildings," by A. F. Dufton, Building Research Station (Great Britain), and Prof. F. B. Rowley, University of Minnesota (United States). (4) "Mechanical Engineering Applications of Insulation," by J. S. F. Gard. In addition, Prof. M. P. Brémond, of the Manufacture Nationale de Sèvres, France, will review the position of heat-insulating materials on the Continent, while Prof. E. A. Allcut, of the University of Toronto, will deal with the Canadian point of view.

Exothermic Ladle Additions to Cast Iron

The last issue of "Foseco News" (the house organ of Foundry Services, Limited, 285, Long Acre, Nechells, Birmingham, 7) carries an announcement that they are now manufacturing and marketing heat-producing ladle additions for the purpose of making alloyed cast iron in the easiest possible manner. Bags of alloys calculated to give definite yields of the desired elements mixed with some heat-yielding material are placed in a ladle of known capacity. The composition of alloys is varied to suit existing specifications.

Developing Indian Business

Sir Thomas Ainscough, C.B.E., His Majesty's Senior Trade Commissioner in India, Burma, and Ceylon, and his colleagues, Mr. W. D. M. Clarke, His Majesty's Trade Commissioner at Bombay, and Mr. A. Schofield, His Majesty's Trade Commissioner at Calcutta, are particularly desirous of meeting visitors from the United Kingdom, as they feel that with their organisation they are in an excellent position to render assistance, either to principals undertaking a special mission of investigation, or to commercial representatives who are developing the sale of goods of United Kingdom manufacture in India. This Department will accordingly be pleased to provide representatives of firms contemplating such a visit with letters of introduction to the Trade Commissioners in question. In addition, an officer of the Indian Section of the Department in London will be pleased to discuss with representatives the proposed tour with a view to rendering assistance not only as regards market conditions obtaining in India at the present time, but also, if desired, in respect of itinerary, clothing equipment, etc.

Decarburisation of Granulated Pig-Iron

In a Paper in "Jernkontorets Annaler," B. KALLING and I. RENNERFELT describe a new method, the R. K.-process, for converting pig-iron into a product with low carbon content, which is suitable as a substitute for steel scrap for remelting in steel furnaces. The pig-iron tapped from the blast furnace is granulated in molten condition in a special device, and the granulated iron is continuously fed into a rotary furnace, where it is decarburised without melting in a gas mixture containing CO_2 and CO in such proportions that decarburisation takes place practically without simultaneous oxidation of iron or other metallic constituents. The composition of the gas mixture in the furnace is controlled by burning the reaction gas leaving the charge and some blast-furnace gas with air, which is blown in a special way towards the inclined surface of the revolving charge. The consumption of blast-furnace gas is very low on account of the exothermic character of the process, and in continuous service substantially no addition of fuel will be necessary if the remaining carbon content of the product is not to be especially low. In principle the R. K.-process thus has a strong resemblance to the Bessemer process. In the Paper the theory of the process is discussed, and the results are given of experiments in the laboratory and from the first furnace on a full industrial scale. The results of 11 days service in a furnace for decarburising 6-7 tons of pig-iron in 24 hrs. indicate that there is no difficulty to keep the carbon content of the product well below 0.10 per cent., and during certain periods the average carbon content was as low as 0.03 per cent.

The Vitreous Enamelling section which normally appears in the first issue of each month has unavoidably had to be omitted. It will be included in our next issue.

Foundry Exhibition Postponed

The organisers of the Engineering and Marine Exhibition, which incorporates the Foundry Exhibition and which was scheduled to have opened on September 14, have announced that, owing to war having been declared, the Exhibition will be postponed. This is a case of history repeating itself, for exactly the same thing occurred in 1914.

The Oxy-Acetylene Convention which was to be held during the run of the Exhibition is also cancelled.

Changes of Addresses

We have received notice of the following changes of addresses :—

Allied Ironfounders, Limited, have removed to Ketley, near Wellington, Shropshire.

The Institute of Metals to Inglestone, 9, Woodfield Lane, Ashstead, Surrey.

Woodhall-Duckham Vertical Retort & Oven Construction Company (1920), Limited, to Uplands, Epsom Road, Guildford.

The Institution of Structural Engineers to Cornerways, Speen, Aylesbury, Bucks.

Associated British Tool Makers, Limited, to The Manor House, Beaconsfield Road, Claygate, Esher, Surrey.

British & Continental Traders, Limited, to 11, Heath Road, Potters Bar, Middlesex.

Random Shots

Whatever one's feelings when listening to the news or waiting about for an air raid there is no evidence of "war nerves" at a sand-bagging depôt. Over the week-end, "Marksman" was one of a band of volunteers for sandbag filling at the local hospital, and as an antidote to the "jitters" it cannot be beaten. Fat spherical men with streams of perspiration running down their faces; thin concave men who had never handled a spade, let alone a pickaxe, in their lives before; athletic schoolboys and girls; trousered women surprisingly strong, mingled together in the shallow excavations. Some sang, others whistled. Of course, the inevitable soul of the party was there gasbagging as well as sandbagging, and flirting in the intervals with the pretty nurses for a special cup of tea. One was apt now and again to get a dig in the back with a pick or have a toe half chopped off by a well-meaning but ill-aiming neighbour and frequently one had to jump out of the way of falling earth to the chorus of "Mind that sod there!"

* * *

Such an atmosphere as prevailed there only goes to show that a man is really happiest when he's working and that is another point worth remembering now that a war emergency is suddenly causing all workers with metals, ferocious or non-ferocious, to work more ferociously than ever, and all cast-iron constitutions will be tested to their utmost of strength.

* * *

It is often said that the difference between perseverance and obstinacy is that whilst one is a strong will the other is a strong won't. It is perseverance that is going to win the present struggle.

* * *

Even way back in the fourteen hundreds Rabelais in his "Gargantua" wrote that "Coin is the sinews of war." That is surely an ageless truth and this country is not poor!

* * *

Little Audrey is long since dead but Dora has come back to take her place. Dora is not likely to be so ribald as was little Audrey and sometimes it is even a shade difficult to appreciate her particular kind of practical joke, but if she is humoured a little, we can put up with her for—how long?

* * *

The Metal Exchange will be meeting on Thursdays at the Northwick Park Hall at Kenton in Middlesex.* For the rest of the week they can meet in their nearest hostelry, appropriately named "The Rest."

* * *

The editorial office, it will be observed, has moved out to High Wycombe. The name of the house, "Culag," sounds like a patent name for one of those secret packets from Germany which from time to time are thrown with a good deal of the abracadabra into the cupola, and which are supposed to produce a metal of Arabian Night's quality. Many of the staff are staying there.

* * *

Whilst talking of names "Marksman" is beginning not to like the sound of his pen name, which savours a little too much of enemy currency, and is seriously thinking of changing it to "Bull's Eye," which, incidentally, is more in keeping with his prowess at darts than the title of the column suggests.

"MARKSMAN."

* This item is unconfirmed—Editor.

according to which the maximum of the liquidus allows (introduction of additions of high melt- on the rate of absorption of gases which will

General Principles Applicable to the Compounding of Alloys by Melting

By Professor ALBERT PORTEVIN

(*Continued from page* 157.)

Thus, under the triple aspect of vaporisation, oxidation,[16] gas absorption, there is an upper limit to the value θ_s of the temperature reached in the liquid state, but this temperature is a function, not only of the metal, but also of all the melting conditions (see Part II), and even of the very conceptions of manufacture and use. It is, moreover, to show the effect of these multiple factors that the subject has taken so long developing. It should be understood it is necessary to take the lower value of the temperature corresponding to these diverse phenomena to evaluate θ_s, the upper limit of the admissible margin for liquid superheating. This margin can in the end be very narrow; as for instance with manganese, because of its liability to oxidise, it cannot be melted in air. Its margin of liquid superheating is therefore nil. Under these conditions it is necessary to work in a controlled atmosphere. Again, for calcium, there is only a time margin when melting *in vacuo*, or still better in argon.

Generally speaking, by modifying the atmosphere, the pressure, the shape of the furnace chamber and above all by separating the metal from its external surroundings by fluxes or coverings, the admissible temperature limit θ_s can be considerably influenced. It must not be forgotten, that so far only the case of "change," $\alpha > 0$, has had consideration. Yet there can be, as has been stated, meltings without change $\alpha = 0$ or even with refining $\alpha < 0$.

In any case, under normal foundry conditions (melting in air or in furnace gases and at atmospheric pressure), the margin of admissible superheating $\theta_s - \theta_f$ is very variable with certain metals, and zero as has been pointed out for some, yet the margin becomes very wide for others as in the case of tin. This margin can also be increased if a refining after melting and before casting is practised.

Refining after Melting

The examination of the refining of metals is beyond the scope of the subject. It is felt, however, desirable to recall that it is done by additions (deoxidants, oxidants or grain-refining), by the action of fluxes and agitation, by bubbling gas through it, by settling and decantation, etc., not to speak of prior treatments of degasification by melting under pressure, slow presolidification, rapid remelting, etc. They are cited for the purpose of recalling that it is possible so to act indirectly on the margin of admissible superheating.

PART IV.—MELTING CONDITIONS AND THE COMPOUNDING OF INDUSTRIAL ALLOYS

Definitions

Apart from rare exceptions, the industrial alloys in common use are mainly composed of one metal in a predominant proportion with respect to the other metals and elements making up the alloy, the proportion of this major metal being usually of the order of 50 per cent. and frequently even exceeding 90 per cent. It is this metal which moreover enables technical alloys to be classified and described as alloys of iron, copper, aluminium, etc. This metal may be regarded as the principal or basic metal of the alloy, the other constituent metals being the secondary components or added metals.

The additions may be distinguished under the following heads:—

(1) *Constitutional*, *i.e.*, those metals whose proportion present is usually included in the ordinary chemical analysis of the alloy, such as tin in the bronzes, silicon in Alpax, etc.

(2) *Compensatory*, *i.e.*, those components added to make up for any deficit in composition due to melting losses caused by volatilisation or by any other change of the components added in the shape of alloys to the charge, such as zinc in the brasses, phosphorus in the phosphor-bronzes, silicon in pig-irons, etc.

(3) *Refining*, *i.e.*, those components added to facilitate the elimination or the dilution of certain impurities, such as O, S, N, gas, etc. Examples of these are deoxidants, desulphurising agents, etc.

(4) *Protective*, *i.e.*, those components added to prevent undesirable changes during melting or later during pouring. Examples which have already been cited are, Ca and Zr with Mg, P in the case of Cu, etc.

(5) *Grain-refining*, *i.e.*, those components, such as Na for eutectic mixtures of Al and Si (Alpax). Such grain-refining additions may become necessary owing to the presence of any of the aforementioned components, *e.g.*, the addition of Zr may cause a coarsening of the grain of Mg, which must then be refined again.

Aspects of the Problem

The problem under consideration has a double object:—(1) To determine the method of adding or introducing the different components of the alloy; and (2) to establish the order in which these additions must be made. The first point may be considered from two points of view, either (*a*) according to the nature of the elements added; or (*b*) according to their form and quantity.

(*a*) As regards the nature of the components added, there are two extreme cases to be considered in practice, either the charge is prepared from metals and other components in the form of virgin metals, or it is prepared by starting with an alloy, either in the form of scrap or ingots of alloys specially compounded for this purpose (standard alloys of given analysis). Between these two extremes, there is the general case which is the most common in practice and in which the charge is made up of partly virgin metal and partly of alloys already compounded. The first extreme is necessarily encountered in the initial manufacture of any alloy, and this case will therefore be discussed first.

(*b*) As regards the form and quantity of the components, there are two points of view which lead to opposite conclusions, according to the prevailing conditions: the rate of solution results in fragmentation with reduction in thickness and consequent increase in the exposed surfaces of the fragments, which is the general case where constituent elements are added, or changes due to atmospheric action increase with the surface and tend towards the formation of larger aggregates or agglomeration, which occurs with scrap, such as turnings, powdery material, strip and wire cuttings, or the inclusion [or bonding] in a cement or a molten metal, as with oxidisable additions.

Alternatives are presented here very similar to those encountered when considering the part played by agitation, whether mechanical as produced by rabbling or mixing, or electromagnetic as produced in induction furnaces. The latter offer advantages in arriving at a chemical and thermal homogeneity by preventing local superheating, and the liberation of the gases in a state of supersaturation, although there are also disadvantages in inhibiting the pouring off of the insoluble impurities (inclusions) and intensifying chemical interaction by multiplying the number of contacts with the enclosing medium, either the gaseous phase (atmosphere), the solid phase (walls of the crucible or container), or the liquid phase (molten fluxes, slag). It is frequently difficult to separate the effects of the three non-metallic phases on the metallic phase, for, as already pointed out, they react conjointly and continuously, the action of the lining being associated with that of the oxidising atmosphere while the reaction products contribute to the formation of the slag.

Properties and Factors Operating

Various factors and properties have to be considered in the melting process and the compounding of alloys; the principal of these are enumerated below, and these will be considered from the point of view of the components as well as from the standpoint of the final alloys:

(1) Relative proportions of the components present.
(2) Relative densities of the components present.
(3) Heats of mixing or combination.
(4) Fusibility (and miscibility). } Defining the range of superheat of the liquid for both the components and the alloy.
(5) Volatility. }
(6) Chemical changes and particularly oxidisability. }
(7) Absorption of gas.
(8) Velocity of mutual solution.

Before reviewing the various possible or recommended methods of compounding according to the relative importance of these factors, the available data regarding these phenomena and properties must first be studied.

Relative Proportions and Densities of the Components

The proportions of the components are determined by the chemical composition sought, with an accuracy or tolerance depending on the type of alloy and its subsequent duty. The densities are also known, either in the solid state or in the liquid state, with an accuracy usually adequate for all practical purposes under consideration here. It may be stated that the difficulties encountered in the compounding of alloys increase with the magnitude of the differences in the quantitative proportions and densities of the metallic components, since these differences adversely affect the ease with which the requisite homogeneity is obtained in the molten state. Moreover, when these differences are very large, certain artifices, to which reference will be made later, must be adopted.

Heat of Mixing and Combination

It has already been stated that the total heat which must be applied to the charge, including the heat of fusion, is interesting as a guide to the fusion mechanism of the metals in special relation to the rate or duration of melting. In the present case, they have to be considered as chilling the liquid bath by the introduction of cold, or solid, metal. It may be asked whether the heat liberated during the formation of the alloy is able to balance this cooling action, either (*a*) by the heat liberated by mixing, solution or combination, or (*b*) by the heat of reaction due to the occurrence of reduction processes.

As regards the quantities of heat evolved during mixing, the researches of Masuo Kawakami (1930)[16a] indicate that for the binary alloys which he investigated: (1) those which do not yield intermediate compounds until the liquidus have negative heats of mixing, *e.g.*, Pb-Cu, Al-Sn, Sn-Sb, etc., while (2) those forming intermetallic compounds up to the liquidus have a positive heat of reaction, indicating that these compounds are not decomposed by fusion, *e.g.*, Al-Cu, Sn-Mg, etc.; (3) certain alloys, such as Cu-Au and Ag-Au, on the other hand, produce no change in temperature and represent examples of ideal solution.

These results concerning the presence of definite compounds may be reconciled to the forms of the liquidus, which are in relation with the degree of dissociation of the definite compounds

according to which the maximum of the liquidus in a state of true equilibrium with the definite compound is either low and flattened or steep and high (as with Ni-Al). In industrial alloys, compounds of the latter type rarely occur; they are, moreover, not to be looked upon as master alloys, for both the benefit of the fusibility and that due to the contribution of the heat of reaction which facilitates the formation of the alloy are lost; at the very most their use can be envisaged in certain cases for equilibrating the melting points of the master alloy added and of the basic metal.

These heats of formation, however, which are usually relatively low, are augmented by the heats of reaction, mainly the quantities of heat due to reduction; *e.g.*, on the addition of the reducing metals Al or P to molten metals or alloys susceptible to more or less oxidation, such as alloys of copper or steels. This may be used advantageously to increase the fluidity of the molten alloy.

Fusibility and Liquid Miscibility

Solidification curves are of great value, if not indispensable, for the scientific preparation of alloys, since they furnish precise and essential information regarding the miscibility in the liquid state and of the fusibility of binary and ternary alloys and sometimes even of quaternary alloys.

(*a*) *Liquid Miscibility.*—The curves indicate the limits of concentration and temperature, the gaps in the miscibility process, and hence the regions of liquid heterogeneity, *i.e.*, of the non-alloyed state, in which the liquid alloy is not stable, particularly if there is a marked difference between the densities of the two phases. Examples of this are alloys of Cu-Pb with a high content of Pb as well as Pb bronzes. These data are also valuable in the choice and the use of the master alloys, *i.e.*, the auxiliary alloys for the compounding of a required final alloy. It is possible to alloy an addition of a metal B non-miscible with a metal A by using master alloys of B with another metal C which is miscible with both A and B, *e.g.*, to alloy Pb which is non-miscible with Al, an alloy of Pb with Mg may be used. Conversely, to add a metal B to A which is not readily miscible with it, an intermediate alloy of B with a third metal C which is not miscible with A may be used, so that C finally separates out. An example of this is afforded by the small addition of a sodium deoxidising agent to molten steel through the medium of an alloy with Pb, which is non-miscible with Fe and more dense than the latter, so that it acts merely as the vehicle for the introduction of the sodium.

(*b*) *Fusibility.*—For each alloy composition, the curves give the lower limiting temperature θ_f of the melting range or of the liquid superheating, these temperatures being moreover the lower limit of the zone or region of the homogeneous liquid phase, *i.e.*, the liquidus, except in the gaps of non-miscibility, at the liquidus horizontal, where θ_f follows the contour bounding the heterogeneous liquid phase.

Very little general information can be given regarding the variation of θ_f in alloys, since the liquidus is very variable and differs from alloy to alloy. The more common relationships encountered in industrial alloys may, however, be conveniently summarised as follows:—

(I) Liquidus descending uniformly from the metal with the higher melting points, *e.g.*, Cu-Sn bronzes, Cu-Zn brasses, Sb-Sn anti-friction alloys.

(II) Liquidus with a low eutectic point, *e.g.*, Al-Si Alpax, Fe-C irons, Sn-Pb soft solders.

(III) Liquidus with one or more maxima, sometimes higher than the melting points of the constituent metals, *e.g.*, Mg-Sn, Na-Sn, Al-Ni.

These considerations of fusibility are fundamental to the compounding of alloys and indispensable in the choice and use of master alloys (introduction of additions of high melting-point, volatile, oxidisable, etc.); a volatile and oxidisable addition such as P can thus be added in the shape of alloys with different melting points, Sn-P or Cu-P, while a high melting point and oxidisable metal, such as Cr, can also be added as a ferro-alloy with a suitable melting point, owing to the presence of C or Si.

Volatibility

The boiling point or θ_e of binary alloys have been determined by Leitgabel.[17] The more general shape of the curves plotted shows a very sharp drop on one side of the metal to the highest θ_e and a slow increase on the other slope for the more volatile metal. It appears that the addition of a volatile element or metal (*e.g.*, P, Na, Zn, Cd) to a molten metal with a high melting point usually entails considerable losses of heat and it becomes necessary to reduce the temperature of the molten bath by the addition of other alloying elements or alloys in the combined state, or to use master alloys.

In exceptional cases, where reference is made to refining additions before dispersal, *e.g.*, deoxidation of steel with Na, Mg or Ca, certain artifices must be used to promote their rapid mixing with the bath by attaching to a rabble, or better still by enclosing them in a cartridge or other suitable receptacle, which will either melt in the bath or require withdrawing again, or by encasing them in refractory cement.

As these additions are of low density (0.97 to 1.7) they must be weighted by another element already a constituent of the alloy or one immiscible with the latter.

To add sodium (θ = 97 deg., d = 0.97) to molten steel (θ_f = 1,600 deg., d = 7), Glasunov[18] used cylindrical cartridges with the upper end perforated and covered with paraffin, and the lower end closed with Pb so as to obtain a mean density higher than that of the molten steel; before the cartridge is melted, the Na escapes through the holes, forming jets of vapour which penetrate the bath. Light, volatile or combustible additions can also be introduced into the molten metal in the form of a projectile.

Although there may be a marked difference in density and they may be volatile and oxidisable, some very fusible elements such as tin can be added in small quantities by means of cartridges or containers to very hot baths such as molten steel, since they melt instantaneously and tend to volatilise if remaining on the surface of the charge. Little information is available of the volatility of alloys which in certain cases reduce the margin of superheating far below θ_e, as already indicated.

Chemical Changes, Oxidation and Absorption of Gas

There are hardly any quantitative data regarding the oxidisability of alloys; but it may be recalled that oxidation is selective, *i.e.*, it takes place first with the more oxidisable components present which act as reducing agents of the other oxides produced, and secondly, the oxide of a metal has only a very weak solubility in the other molten metals, although these may dissolve a fair proportion of their own oxides.

It follows therefore that the most oxidisable elements and metals will provide a protection against oxidation if their oxides are solid at the temperature of the molten charge, whence the interest attaching to the initial fusion in air of the principal metal or of the alloy already formed, by the previous addition of small quantities of deoxidising agents.

The solubility of hydrogen in alloys has been investigated by Sieverts, his results indicating that the solubility in a metal (copper or palladium) can be considerably increased or reduced by alloying with other metals. These results, however, relate to only two metals and moreover there is little information available on the rate of absorption of gases which will permit the deduction of any laws or general hypotheses in respect of the compounding of alloys from the point of view of the variations in the limit of admissible superheating θ_e. All that may be said is that this latter factor is closely related to the most volatile and more oxidisable element present in the bath. What appears most certain is that the range of superheating to the greatest extent appears to correspond with the eutectic alloys.

Compounding of Alloys from Component Metals or Virgin Metals

Assume that A is the principal or basic metal and B one of the metals or elements which has to be added. Consultation of textbooks of foundry practice or inquiry from practical foundrymen as regards general instructions for the order in which the constituent elements or metals of an alloy should be added, brings to light the most contradictory advice; according to some authorities the component with the highest melting point should first be melted, others favour starting with the component having the lowest melting point. The only point on which there is more or less general agreement is that the components to be added last are those which are the most oxidisable and the most volatile.

In this state of affairs, metallurgists must accept as a starting point that principle which appears the most simple from a practical point of view: First melt the principal metal and then add the additions in the order of their melting points and with decreasing margin of superheating. Hence in compounding a bronze, a Cu-Sn alloy, rich in Cu, the copper should first be melted and the Sn then added; in making an anti-friction metal of Sn-Cu rich in Sn, the tin should be melted first and the Cu then added. This process may be termed "working with constant heating and solid additions," for the variations in the temperature of the bath are principally due to the chilling effect (excluding exothermic reactions) of the additions.

The question of the relative quantitative proportions of the metals can therefore be set aside for the moment, and primary consideration given to the "admissible margin of superheating." An examination will be made of the principal cases and phenomena with this method of procedure in order to arrive at the essential modifications and corrections.

Phenomena Occurring on the Addition of a Solid Component B to the Molten Metal A

If the principal metal A melts at a temperature θ within the temperature range $\theta_{A^1} - \theta_A$, and a metal B is added with a melting-point range $\theta_{B^1} - \theta_B$ in such small quantity that the temperature θ is not substantially altered (which depends as already stated on the thermal properties of the two metals), and if B rapidly acquires the temperature of A, a distinction can be drawn between the following cases:—

I.—The thermal ranges of superheat of the liquid metals A and B have a common range of temperature; the ranges can hence be said to be concordant. Take the temperature θ in this common range, when the metal B will melt and diffuse through charge A. Two separate cases can be distinguished here: I*a*—where temperature θ is above the maximum of the liquidus of the fusion diagram of A-B. The solution of the added component B is determined by the rate of diffusion of the two molten metals, which as a rule is very high. In addition, mechanical stirring will cause a rapid equalisation of the relative concentrations and result in the production of an alloy of homogeneous composition. The manufacture of this alloy is not difficult and will serve as a type to which it is desirable to reduce every practical case of alloy manufacture. *Examples*: Alloying of bronze to lead (Cu-alloy with 30 per cent. Pb), alloys of Al with Mg, Sb, Zn and Sn, Cu-Ag alloys.

Where certain deoxidising agents are added, such as Al, to oxidised metals, such as Cu, the particles of molten Al may be coated with a film of Al_2O_3, which prevents proper diffusion; agitated stirring is then necessary with the addition of a flux for dissolving the Al skin.

1*b*.—*Temperature θ is lower than the maximum of the liquidus in the A-B diagram.* As before, B will melt and diffuse through A and produce within the liquid an intermetallic compound A_mB_n corresponding to the maximum of the liquidus. This compound, which can be decanted, is responsible for heterogeneity during tapping, the first castings or ingots having a different composition from those cast later.

Examples: Manufacture of a Pb-Na alloy (in practice, the reaction is sufficiently exothermic to cause the temperature of the charge to rise above the maximum of the liquidus; advantage may be taken of this by pouring at this point).

II—*Margin of Superheating of A is Lower at the Melting Point of B.* In this case, the temperature θ of the molten bath does not reach the melting point of B, which therefore does not melt and must be dissolved in A; the state of superheating of B has thus also an important influence. Three different cases must be considered here:—

II*a*—Metal B is enclosed by a film of oxide which is very adherent and completely isolates B from A; B then cannot dissolve A.

Example: Al added in solid ingots to a eutectic of Pb-Sn (refining of "claire de soudure"*). Even when added to the bath at 600 deg., the Al does not dissolve.

II*b*—The metal is enclosed by a film of oxide which is eventually penetrated by A. Solution of B in A at first zero gradually increases (see below). The permeability of the oxide increases with an elevation of temperature. It is the higher, the further removed the temperature is from the melting point of A. The mechanism of this penetration has not yet been studied.

Example: Solution of copper additions in tin (manufacture of anti-friction metal), solution of Fe additions in certain special solders. The solution of these additions is zero at low temperatures if the surface of the metal has not been broken. This case is encountered with refractory deoxidants such as Si; also the melting point of the addition must frequently be lowered when working with a master alloy. Moreover, flux dissolving the oxide should be added while agitating.

II*c*.—There is no coating of oxide or if present it has no retarding action (*examples:* solution of Pb and Sn, the manufacture of solders), or its action is destroyed (see case II*b* above).

Where the A-B diagram does not disclose any definite compounds, there is simple solution of B in A governed by the velocity of diffusion in the liquid of the atoms of B contained in the liquid film, saturated with B, of the alloy (A + B) surrounding B; solution is rapid and accelerated by increasing the temperature, and fragmentation of the materials increases the area of the exposed surfaces, and above all mechanical stirring accelerates diffusion within the molten mass.

Examples: Solution of Zn and Sn (manufacture of special tinning alloys), solution of high melting-point elements in industrial metals, even those melting at a high temperature such as Fe, or elements less fusible in metals melting at moderate temperatures such as Al (alloys of Al with Cr, Cu, Fe, Mn, Mo, Ni, Si, Ti). This case is necessarily found where the means available for melting the metals do not allow the melting-point of B to be reached, when the alloy obtained by pure diffusion is frequently not homogeneous, *e.g.*, to alloy O_2 with Fe, the former being the least fusible of the Pt family (θ_f= 2,700 deg. C.), Fallot[19] obtained solution in superheated iron by means of an induction furnace and operating *in vacuo* found it necessary to remelt three times to ensure proper homogeneity of the alloy.

This is not an industrial process and the question arises as to whether metals and elements with very high melting points, such as W, Mo, Cr., etc., should only be alloyed by means of master alloys with lower melting points, compounded in the electric furnace and used for many years under the general classification of ferro-alloys. Where, however, these ferro-alloys are added to molten iron, at a temperature lower than that of molten steel, the melting point of these additions is further reduced by the incorporation of other elements; thus Si is added to Ni (θ_f = 1,260 deg. C. for 6 per cent. Si), to ferro-chrome (*e.g.*, 10 to 12 per cent. Si for 50 to 55 per cent. Cr), to ferro-molybdenum (*e.g.*, 10 per cent. Si for 40 to 45 per cent. Mo), to ferro-titanium and so on. Here again the state of granulation is of major importance from the point of view of the rates of solution and oxidation; the size of the grains must therefore

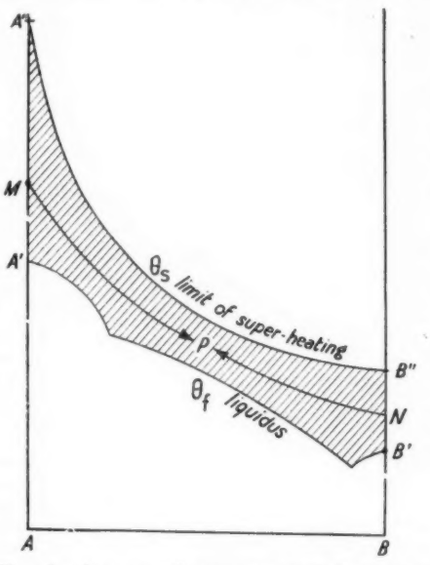


Fig. 1.—Limit of Superheating = Limite de surchauffe.

be controlled[20] with each ferro-alloy if the additions are to be made in the ladle or in the tapping spout of the cupola (in the latter case, the grains must be distributed with a uniform velocity in all directions where they will agitate the metal by eddying, *e.g.*, at the mouth of the spout or where the stream of metal enters the ladle).

In these cases of more or less rapid solution, the differential density factor may enter, for if the density of B is much less than that of A, B will rise to the surface; lumps of B must then be enclosed in perforated containers, either of metal or refractory materials, such as graphite, according to the conditions ruling, and a handle of suitable length used to keep them beneath the surface of the molten bath.

In all cases, there is a tendency in favour of the compounding of master alloys formed by the addition element and the base metal and with a margin of superheating conforming with the latter so that the conditions obtained are as set out in case I above.

It should be noted that where the A-B diagram indicates the formation of a definite compound, the surface of B in contact with A will become covered with a film of the latter. The velocity of solution will then depend on the diffusion of the atoms of B with respect to A (or inversely) within this film of the solid compound. The solution of the addition is slow (Ni in Sn, Fe in Sn), at least when the temperature is raised above that of the melting point or the dissociation point of this compound (*e.g.*, addition of Sb in anti-friction alloys, solution which is very slow at 300 deg. becoming very rapid at 500 deg.). Solution can be accelerated in this case by using B in small lumps.

Summarising, it may be stated that the use of ferro-alloys is not essential in principle in cases Ia, Ib and IIc where no film liable to retard solution is formed, either in the form of a definite compound or as an oxide.

On the other hand, in case IIa, it is an advantage to use a master alloy above the melting point of B. *Example*: Refining of solders with Al, which is melted separately and alloyed with three times its weight of solder. The solder thus obtained will dissolve more quickly (for reasons of economy the temperature of the solder bath cannot as a whole be raised to the melting point of Al).

In cases IIa with slow solution (additions with high melting points), IIb and IIc (with the formation of a retarding coating), some change in the bath may take place, *i.e.*, reduction of θ_s by increasing the duration of the melting process; this may be avoided with heavy metals little susceptible to the absorption of gases, by the addition of protective fluxes. This will, however, not apply to volatile additions, where θ_s is depressed in spite of the addition of fluxes and it is preferable to use a master alloy. *Example*: In making alloys of Cd and Ni, there is a considerable loss of Cd if the bath even when carefully covered is only 50 deg. above the melting point of Cd. The use of master alloys may also be favoured in the following case, which is derivable from case I.

III.—*Melting Point of A is above the Margin of Superheating of B.* This case arises where the addition B is either very volatile or very oxidisable; recourse can again be made to various artifices for introducing these additions, as already outlined above. Examples are the addition of P, Na, Zn, Mg, to the high melting-point metals Cu and Fe.

The component B may be melted within its margin of superheating, adding little by little to the molten metal A and[21] owing to the elevated temperature in such a way as to increase progressively both the concentration and the temperature, while remaining within the margin of superheating of the alloys in the diagram (elevation of temperature may be avoided by adding B in the solid state). The thermal curve of the operation is MP between θ_f and θ_s on the diagram. This variation in temperature is, however, not feasible in current foundry practice, but may be employed for corresponding master alloys, such as Al-Cu, P-Sn.

The same applies to the inverse process in which increasing amounts of the more fusible metal are added in the solid state to the higher melting-point metal when molten, so as to increase progressively the concentration by reducing the temperature and to remain within the margin of superheating in the diagram; the thermal curve of this operation is MP in the diagram, although this much easier method must also be considered.

Compounding Alloys from Previously-Prepared Alloys

In this case the charge is entirely made up of scrap and ingots already having the final composition sought. The only precaution to be taken is to reduce to a minimum the losses in oxidisable and volatile elements and to make up for any losses and chemical changes sustained,[22] either by: (1) Reduction to a minimum of the exposed surfaces, by previous briquetting or covering with cement; (2) employing a flux for fusion and protection which dissolves the oxides formed on the surface and prevents atmospheric attack, the more so in view of the high state of division of the materials (turnings, wire, thin sheets, etc.); additionally, there is the potential use of charcoal on surfaces, and (3) protective

* *Translator's Note.*—This is thought to be a special type of solder.

additions with deoxidising and compensating action.

The simplest case in foundry practice, which requires the least number of precautions and technical skill, is the melting of standard ingots, *i.e.*, of ingots specially prepared as regards composition and shape, reducing to a minimum the difficulties of processing. This is the limiting case of a master alloy extended to all alloys, instead of being restricted to the introduction of certain elements.

This initial ingotting represents a first solidification of the alloy, a solidification which can be carried out at will, instead of being dependent on actual casting operations in the foundry. It is thus possible to control the conditions of this solidification to effect degassing and with the minimum of segregation. The preparation of an ingot is thus frequently valuable from the point of view of soundness and final heterogeneity.

If the charge is partly made up of component metals and partly of alloys already formed, the latter should be considered as an element of the charge with a proportion, density, melting point and a margin of superheating all determined, and in consequence the considerations and rules enunciated above will apply here.

PART V.—SUMMARY AND CONCLUSIONS

I.—Compounding of Alloys in the Foundry

The two simplest cases permitting constant heating of the charge and dispensing with the need for a special atmosphere, with or without a flux, are as follows:—

(1) Remelting of alloy ingots with the required composition (standard alloy ingots).

(2) Preparation of alloys starting with metals and alloys with concordant ranges of melting or superheating. (It should be remembered that the use of a flux and the melting rate enable the margin of superheating to be considerably increased in this case.)

All cases can be reduced to one or other of these types or at least very close to either. This may be done either by (1) making initial ingots, or (2) by using master alloys chosen with margins of superheating in agreement with those of the other elements in the charge (metals or alloys). It appears that this method of interpretation actually only begs the question, since it is still necessary to compound alloys either as ingots of the required composition or as master alloys; this is actually what takes place. The difficulties of an alloy are related to a previous operation, which may be outside current manufacture, or again be carried out by specialists.

Recourse can usually be had, for the obtaining of master alloys, to all sorts of conditions of compounding, which are either unusable or too complicated for ordinary foundry practice. It is beyond the scope of this Paper to enter deeply into the question of the manufacture of master alloys, and the subject has been confined to outlining some fundamental principles.

II.—Choice and Compounding of Master Alloys or Additive Alloys

The choice of the composition of a master alloy designed for incorporating an alloying element M is determined by the following considerations:

(1) A melting point close to that of the base metal or alloy and a margin of superheating comparable with it.

(2) Chemical homogeneity, *i.e.*, absence of segregation, demanding the use of eutectic alloys and pouring in thin seams.

(3) Proportion of M sufficient to reduce the proportion of the master alloy to be added.

(4) Adequate chemical stability.

(5) If possible having a composition in which the components are in simple proportions to each other ($\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{10}$), taking into consideration any subsequent losses to simplify and accelerate calculation.[22]

(6) Permit easy fragmentation for adjustment of the weight of material to be added to the charge. This may be done either by casting notched ingots or by getting samples capable of being split up by drilling or shearing or by previous breaking up to the required size, or by making fragile alloys which can be broken with a hammer (tending towards materials defined as compounds of a non-metallic character).

This may be done through the use of binary, ternary and more complex alloys formed by the element M, either with a base metal, or with other elements of the alloy, or even with additional elements which do not adversely affect the qualities of the final alloy.

In all cases, the diagrams form the starting point and provide the indispensable basis for the choice of the master alloys. The frequently important part played by certain impurities or elements, however, in respect of fusibility and solubility, such as carbon in the ferro-alloys, should also be kept in mind.

In one case, fusible phosphorus or refractory silicon is supplied to the foundry in the form of alloys with different melting points and with different base metals, *e.g.*, P with Sn, Zn, Cu, Fe, etc., and Si with Al, Cu, Ni or Fe.

Compounding of Master Alloys

For this purpose all kinds of processes can be employed for compounding the alloys which may prove too complex for ordinary foundry use or even quite useless in foundries. The margin of superheating must be considerably extended by using specific atmospheres, or melting *in vacuo*, etc., which enable the temperatures and duration of superheating to be increased, thus promoting the rate of solution.

Various methods of compounding may be used: Mixing metals already in the liquid state, melting at temperatures which are varied during compounding, *e.g.*, in the electric-arc furnace, the resistance furnace, the induction furnace, for compounding, for reduction with C, Si, and master alloys containing high melting-point elements (Si, Cr, Ti, Zr), or even volatile constituents (ferro-phosphorus); by cementation to avoid impurities, as in a cemented bar as used to be used for crucible steels[24]; by the compression and sintering of powders; by electrolysis in the molten state (example of borides of alkaline metals, alkaline earths of normal or special refractory composition) or in the aqueous state; by aluminothermy and silico-thermy, etc.; by the reduction of salts such as chlorides, metals such as Al (preparation of master alloys of Al with Co, Mo, Ti).[25] More generally all chemical processes for the preparation of elements can be used with advantage. The use of these master alloys has been widely developed in steel-foundry practice and in non-ferrous foundries handling Cu, Ni and Al.

In general, the practical rule followed in the majority of these various types of foundries regarding the order of adding the components to the bath is as follows:—(1) Principal metal or base alloy; (2) master alloys; and (3) before pouring, volatile elements or final additions (except where the interaction of the latter must be completed to permit quiescent pouring).

To complete this outline of the principles for compounding alloys in foundry practice, reference should also be made to the choice and use of melting fluxes and slags, but this subject merits separate discussion on broad lines and for this reason will not be discussed here.

Conclusion

In this study of the general principles applicable to the compounding of alloys, an attempt has been made to regard the whole subject from its various aspects and to enumerate the different factors and conditions entering, without losing sight of the incompleteness of the investigation and the extreme generalisations which have been made to effect simplicity; the present Paper does not advance a doctrinaire theory, but is only a tentative attempt to arrive at a systematisation, incomplete as well as imperfect, in order to promote observations, comparisons and criticisms as well as a discussion which it is hoped will lead to a more satisfactory analysis and synthesis of this important problem on more concrete and more concise lines.

REFERENCES.

16 For some metals, sulphurisation can be added.

16a Reference should also be made to the thermo-chemical researches on the direct determination of the heats of formation of binary and ternary alloys of Co-Al, Co-Sb, Co-Si, Co-Sn, Cu-All Cu-Sn, Cu-Zn, Fe-Al, Fe-Sb, Ni-Al, Ni-Sb, Ni-Sn, Sb-Zn, Fe-Ni-Al, Fe-Co-Al, Cu-Ni-Al, Fe-Al-Si, by Fr. Koerber, W. Oelsen, W. Midde, and H. Lichtenberg (Mitt. K.W.I., vol. xix, No. 1, pp. 1–26; No. II, pp. 13–159; No. XV, pp. 209–219).

17 Sieden von Metallen und Legierungen bei Atmosphärendruck. Zeit. f. anorg. u. allg. Chemie, 202, p. 305. (1931).

18 R.U.M., 8th Series, IV, October, 1930.

19 Annales de Physique, 2ème Série, vol. 10, p. 312, October, 1938.

20 Cf. P. F. Viandon. L'emploi des ferro-alliages en fonderie. Bull. Assoc. Techn. Fonderie, X, p. 326, Sept., 1936.

21 Previous oxidation of the metal A may take place when B is a reducing agent, such as Al, in order to prevent violent exothermic reactions.

22 We shall not here recall the considerations advanced regarding the classification of scrap referred to previously.

23 Thus a proportion of 50/50 is used for master alloys of Al-Fe, Al-Cu, Cu-Mg, Cu-Ni, and 75/25 for Al-Ti, Cu-Si.

24 It is possible to extrapolate for high melting-point metals with volatile chlorides or halides (Si, Mo, Ti).

25 Certain chlorides and fluorides can in fact be used directly for introducing the elements to the bath, such as Ti to a bath of an Al alloy.

Publications Received

The Sir John Cass Technical Institute Calendar for the Session 1939-1940.

Because of the personal interest which the Principal, Mr. George Patchin, takes in metallurgy and foundry practice, the Institute now ranks amongst the foremost teaching and research centres in the country. The teaching staff includes a number of authorities whose names are well known in metallurgical circles. The Calendar discloses that there are now full-time day courses in metallurgy as well as a well-arranged series of evening studies. To the equipment of the foundry there has been added a 35-kva high-frequency furnace. The testing laboratory is particularly complete and contains a 30-ton Buckton and a 50-ton Macklow-Smith (a fairly recent addition) machine, and all the usual smaller types of machines. The whole of the department is in fact well equipped, both for teaching and the carrying out of research.

Summing up, the Calendar discloses that the Institute has been very successful in London University examinations for degrees in metallurgy; that the evening classes in metallurgy retain their popularity, and that the day courses in metallurgy are recognised as being of high-grade University standard. Intending students will no doubt receive a copy gratis on writing to the Principal at Jewry Street, Aldgate, London, E.C.

Welfare at Stanton. Published by the Stanton Ironworks Company, Limited, near Nottingham.

The reviewer is not at all clear in his mind just what the object is in publishing such a brochure as this, but at any rate he found it unusually interesting to peruse. It is excellently printed and illustrated, and shows clearly how seriously the management of this very large undertaking regards the question of welfare. This is no place to theorise on the subject of welfare, but those interested will find a description of an all-embracing scheme well designed to suit a large-scale undertaking employing mainly male labour in heavy industry. The present time shows up very vividly the extreme utility of a well organised welfare department, for in many cases it is the duty of this section to take care of the operation of air raid precaution activities. At the worst it is a ready-made organisation readily adapted to the needs arising from war conditions, which saw their original creation.

Producing a Large Iron Casting by the Randupson Process

By G. LONGDEN

Numerous advantages are claimed for the cement-mould process for producing iron castings. Of primary importance is the high quality of the casting. This can be attributed in the main to the high resistance of the cement-sand structure to the molten metal. The metal can be poured at a high temperature without danger of scabbing or washing—a distinct advantage in the production of sound castings. Blowholes are not entirely eliminated, but they are not so pronounced with cement bonded sand as in other moulding sand. Gas is practically eliminated because of the inert nature of cement bond, but any gas which is generated has free escape through the walls of the mould owing to the highly porous nature of the sand.

FIG. 1.—CASTING FOR SLIPWAY HAULAGE PRODUCED BY RANDUPSON PROCESS.

The process, which was first exploited in France, is based on the principle of using moulds made from silica sand and cement, with water added. The mixture has a consistency similar to sand used for oil-sand cores. The sand is pushed rather than rammed round the pattern by means of plungers. Wood boxes or frames with a quick taper are used instead of iron boxes. These frames are removed immediately after the pattern has been withdrawn, and by this means large numbers of moulds can be made from one moulding box. The moulds are reinforced with loose irons, and staples built in, to enable their removal to stacking, closing, or casting departments.

There is no artificial drying of cement-bonded moulds; small moulds are allowed to dry under atmospheric conditions 48 hrs., and large ones 72 hrs. Blacking is brushed on the moulds similar to dry or loam moulding practice, and this is allowed to dry under the same atmospheric temperature. Not only can cement-sand be used for moulds made from full patterns, but also for strickle work, such as the casting which is the subject of this article.

Slipway Haulage Casting

Fig. 1 is a photograph of one of two castings produced by the Randupson process by David Brown & Sons (Hudd.), Limited, Penistone Works, for outside customers. This casting, required for slipway haulage, measured 11 ft. 6 in. long (including 1 ft. 6 in. head metal) and 7 ft. 8 in. inside diameter. The wall thickness was $3\frac{1}{8}$ in. and the plated portion $1\frac{3}{4}$ in. The weight of the casting was $20\frac{1}{2}$ tons.

FIG. 2.—BOTTOM PART OF MOULD.

The pattern requirements were exactly similar to those for loam moulding, *i.e.*, strickles and loose pieces. The bottom part of the mould shown in Fig. 2 was supported by a bottom plate 10 ft. 6 in. dia. and 6 in. thick weighing 6 tons approx. A grid was also bolted on the plate to support the sand between the ribs.

Heavy chills were inserted at the junction of the ribs and boss (Fig. 2, at A). These chills were not only for the purpose of obtaining a sound bore, but also to assist in a more uniform cooling. There was a danger of fracture with the heavy boss metal joining up to the thin plated section, although the latter was heavily ribbed.

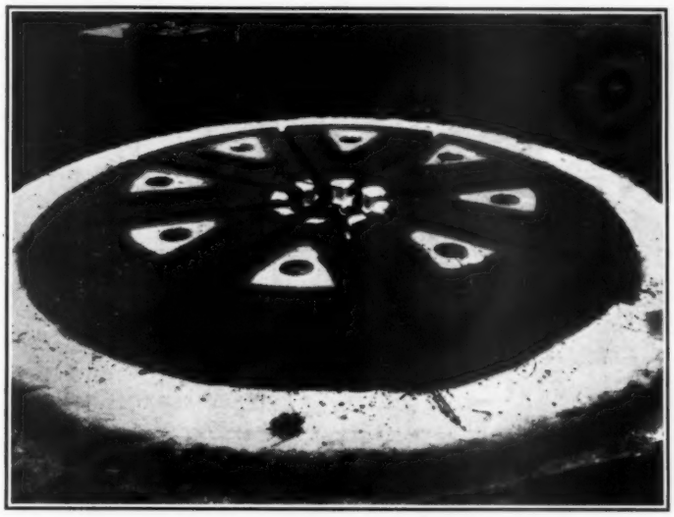


FIG. 3.—METHOD OF FORMING MOULD AND CORE.

The mould was built in four sections; each portion was supported by a cast-iron ring with staples cast in for lifting purposes, and reinforced at intervals by loose irons, horizontally and vertically round the circumferences. The mould and core were formed as shown in Fig. 3. On the left is a section of the core in the ramming-up stage. Loose boards are set and wedged lightly to form the inside of the core, and shuttering to form the outside. A wall minimum allowance of 9 in. thick and a minimum allowance of surplus to be removed by the strickle were decided upon. On the right is a portion of the mould, with the octagonal shuttering removed.

Fig. 4 shows the lower section of the mould assembled; this includes bottom part, one section of the mould, and core. Fig. 5 shows a general arrangement of the mould assembled, and it will be seen that every precaution was taken to ensure there being not the slightest movement during casting. The calculated upward thrust on the core was approximately 41 tons. On the bottom plate A, iron packings were built up to the top of each of the eight panels as at B.

The lower part of the core forming the inside of the plated portion is a little out of proportion in depth of sand, a similar amount only being used as on the bottom place. This core plant C was made 4 in. thick, and less in diameter than the internal flanges of the casting. Suitable stumps were cast-on, as at D, to meet the packing on the bottom plate and over each panel.

A grid was bolted on the plate to carry the sand between the ribs and sand on the diameter not supported by the core plate. This bottom part of the core was swept up in the reverse position to a point level with the core plate, and after sufficient time had been allowed for setting, was blacked and turned over. The re-

mainder of the core up to the first internal flange was then built on.

Assembly Details

In Fig. 4, the assembling of the parts seen in the pit was carried out on logs on the foundry floor. After the lower part of the core had been placed in position, wedges were inserted between each of the iron packings on the bottom plate and stumps on the core plate. Holes sufficiently large were allowed over each panel to enable the moulder to get his hand down to do this wedging. A bolt 1⅛ in. diameter was placed through each of the eight panels as at E, thus tying the core firmly down to the bottom plate.

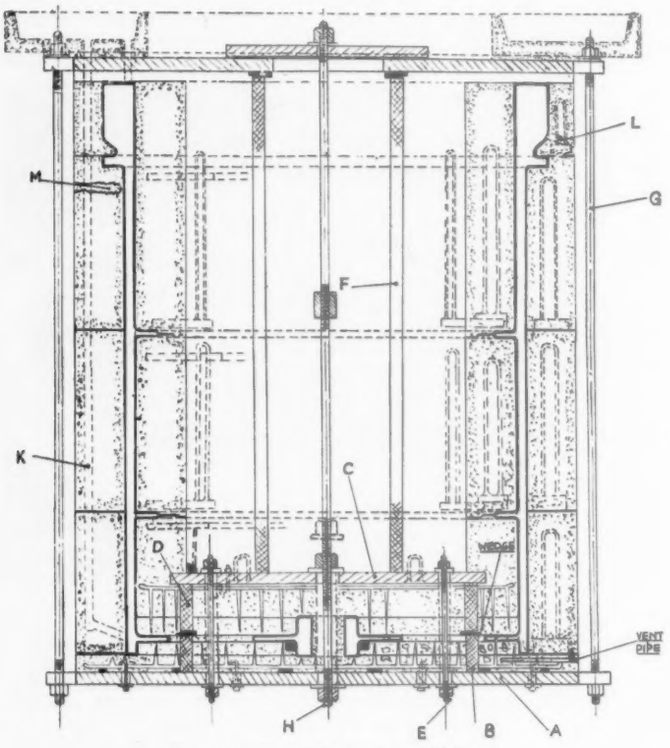


FIG. 4.—CONSTRUCTION OF MOULD.

FIG. 5.—LOWER SECTION OF MOULD ASSEMBLED.

Space was also allowed for a 2-in. diameter bolt to pass through the centre core of the boss. This bolt was made in two lengths to enable its adjustment before placing the mould in the pit. After setting the lower portion of the mould in the pit on a sound bed of sand, the nuts on the bolts on the inside of the core were screwed up to allow the holes round the bolts to be rammed up, and thoroughly sealed. The nuts were then screwed tightly. A further precaution was taken by fixing cast-iron supports from the core plate to the underside of the top plate as at F, this being wedged after the mould had been secured.

Eight 2-in. bolts as at G were used to secure the structure together, but before these were tightened up, iron packing supports were built up between the bottom and top plates at four points to take the weight of screwing down.

The centre bolt H supported across the top plate by two cross-members was the last screwing-down operation. The gating system was carried out by one bottom runner 2½ in. square as at K and fourteen 1½-in. dia. top gates equally divided round the circumference. The top gates were covered with plugs, which were lifted when approximately two tons of metal had entered the mould through the bottom gate.

Casting Conditions

The metal for pouring was contained in two ladles of 10 tons and 15 tons capacity. When the metal appeared at the release riser L, situated six inches above the flange, pouring ceased and the ladles were removed. After the runner metal had drained through the risers, the latter were botted up, and a third ladle containing four tons of hot metal was used to fill slowly the remainder of the head. Six hours after casting the sand immediately below the flange as at M was removed to allow a general downward contraction.

Photographs are sometimes misleading but in this case it must be stressed that this is not so. The only mark which appeared on the casting occurred on the bottom rim over an area of 3 in. by 2 in. This was caused by the metal washing one of the top runner plugs, before the bottom was filled by the bottom grate. Even this only removed the blacking facing from the area stated.

The temperature of the metal taken in the runner box was 1,150 deg. C., and the analysis was:—T.C, 3.45; Si, 1.65; Mn, 0.56; S, 0.089, and P, 0.73 per cent. The test results were:—Tensile, 15.30 tons per sq. in.; transverse (bar 1.2 dia. by 21 in. broken on 18-in. centres), 2,628 lbs., and deflection, 0.24 in.

The Iscor Works in 1938

PLANT EXTENSIONS AND OUTPUT DURING THE YEAR

THE Iscor Works of the South African Iron & Steel Industrial Corporation, Limited, situated at Pretoria West, were operating to capacity during 1938, states the Annual Report of the Government Mining Engineer of the Union of South Africa, for the year to December 31 last. Various additions and alterations to the plant (excluding mines and quarries) were completed during the year as follow.

The erection of tar emulsion plant and tarphalte storage tank at coke ovens; the provision of an electrifying grab crane, construction of launder from Theisen plant to cooling ponds, and additional water seal at blast-furnace gas bleeder on the blast-furnace plant; the erection of 20-ton open-hearth furnace, underground collectors for Wellman chargers, electrically-operated slides, and a cement gun for calcining plant in the steelworks centre; new motor-driven rollers, alteration to reheating furnace, extension to bloomyard, equipment at sheet bar transfer skid, and additional work on spray pipes on the heavy mill; the erection of Quast repeater at the light mills; extension to stockyard and additions and improvements to sheet works; the provision of a sand conditioning plant, a 5-ton weighbridge, and electric lifting blocks in the foundry, and various work in the traffic department, the workshops, etc.

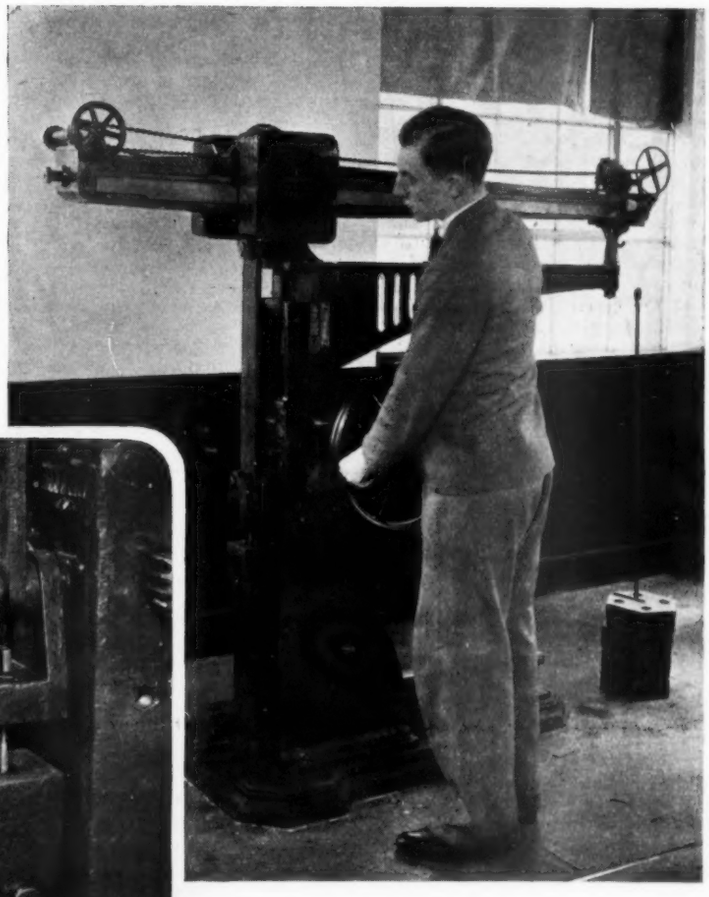
The various raw materials and fuel received by the Corporation during 1938 included 45,593 short tons of Natal coking coal, 24,168 tons of discard coal, 267,684 tons of washed Transvaal coal, 121,372 tons of raw Transvaal coal, 45,083 tons of purchased coke, 117,038 tons of dolomite, 70 tons of ferro-manganese, 150 tons of ferro-phosphorus, 305 tons of ferro-silicon, 868 tons of fluorspar, 48,866 tons of Marble Hall limestone, 25,129 tons of Taungs limestone, 49,558 tons of manganese ore, 23,161 tons of scrap, and 435,043 tons of Thabazimbi ore.

Production in 1938 included: At the coke ovens, 2,487,780 galls. of crude tar, 526,345 tons of crude benzol and substantial outputs of derived products. The blast furnaces produced 299,595 tons of pig-iron of all grades and the steel melting plants 330,201 tons of steel ingots. The output of the heavy mill was: Sections (angles, channels, joists, shaft guides, flats, flanges, welding rods, and rounds), 33,884 tons; rails and sleepers, 61,548 tons; blooms, 3,049 tons; light mill billets, 42,487 tons; other billets, 63,008 tons, and sheet bars, 59,696 tons. Light-mill products were: Rounds, 28,178 tons; flats, 3,884 tons; angles, 2,872 tons; wire rods, 1,117 tons; fencing standards, 1,142 tons. Sheet-works products were: Hard black sheets for galvanising, corrugated, etc., 35,748 tons, and plates, 12,328 tons.

Catalogue Received

Moulding Machines.—A four-page leaflet received from W. J. Molineux (Foundry Equipment), Limited, of Bhyllis Lane, Wolverhampton, describes and illustrates a new line of hand-press, direct-draw moulding machines. The machine is made in two sizes (HT1 and HT2), carrying a 4-in. and a 5-in. pattern draw using 16½-in. and 20-in. (max.) wide boxes respectively.

GLANTON *for* TENSILES



Tensiles of 12-14 tons per sq. in. are regularly obtained on mixtures using Glanton as a basis.

Analysis

Graphitic Carbon %	Combined Carbon %	Total Carbon %	Silicon %	Sulphur %	Phos. %	Mang. %
3.35	0.35	3.7	2.0-3.5	.02-.04	0.5-0.75	0.7-1.0

Glanton can be confidently used for the general strengthening of all cupola mixtures at small cost. A series of mixtures using Glanton were made in an 18" Cupola to ascertain the strength which could be expected in the average foundry where high grade metal is required. Full particulars are available on application.

The Stanton Ironworks Company Limited, Near Nottingham

The largest producers of foundry pig iron for the free market in Great Britain.

mainder of the core up to the first internal flange was then built on.

Assembly Details

In Fig. 4, the assembling of the parts seen in the pit was carried out on logs on the foundry floor. After the lower part of the core had been placed in position, wedges were inserted between each of the iron packings on the bottom plate and stumps on the core plate. Holes sufficiently large were allowed over each panel to enable the moulder to get his hand down to do this wedging. A bolt 1⅛ in. diameter was placed through each of the eight panels as at E, thus tying the core firmly down to the bottom plate.

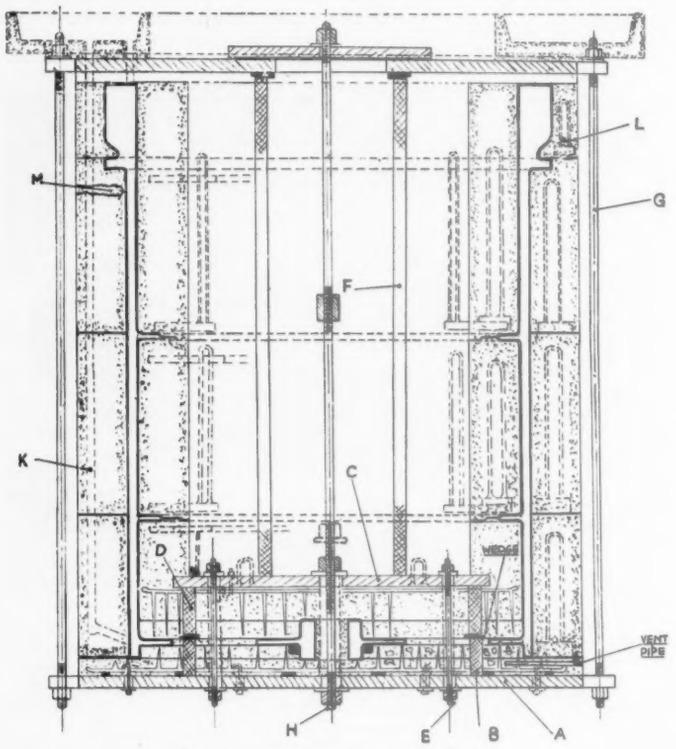


FIG. 4.—CONSTRUCTION OF MOULD.

FIG. 5.—LOWER SECTION OF MOULD ASSEMBLED.

Space was also allowed for a 2-in. diameter bolt to pass through the centre core of the boss. This bolt was made in two lengths to enable its adjustment before placing the mould in the pit. After setting the lower portion of the mould in the pit on a sound bed of sand, the nuts on the bolts on the inside of the core were screwed up to allow the holes round the bolts to be rammed up, and thoroughly sealed. The nuts were then screwed tightly. A further precaution was taken by fixing cast-iron supports from the core plate to the underside of the top plate as at F, this being wedged after the mould had been secured.

Eight 2-in. bolts as at G were used to secure the structure together, but before these were tightened up, iron packing supports were built up between the bottom and top plates at four points to take the weight of screwing down.

The centre bolt H supported across the top plate by two cross-members was the last screwing-down operation. The gating system was carried out by one bottom runner 2½ in. square as at K and fourteen 1½-in. dia. top gates equally divided round the circumference. The top gates were covered with plugs, which were lifted when approximately two tons of metal had entered the mould through the bottom gate.

Casting Conditions

The metal for pouring was contained in two ladles of 10 tons and 15 tons capacity. When the metal appeared at the release riser L, situated six inches above the flange, pouring ceased and the ladles were removed. After the runner metal had drained through the risers, the latter were botted up, and a third ladle containing four tons of hot metal was used to fill slowly the remainder of the head. Six hours after casting the sand immediately below the flange as at M was removed to allow a general downward contraction.

Photographs are sometimes misleading but in this case it must be stressed that this is not so. The only mark which appeared on the casting occurred on the bottom rim over an area of 3 in. by 2 in. This was caused by the metal washing one of the top runner plugs, before the bottom was filled by the bottom grate. Even this only removed the blacking facing from the area stated.

The temperature of the metal taken in the runner box was 1,150 deg. C., and the analysis was:—T.C. 3.45; Si, 1.65; Mn, 0.56; S, 0.089, and P, 0.73 per cent. The test results were:—Tensile, 15.30 tons per sq. in.; transverse (bar 1.2 dia. by 21 in. broken on 18-in. centres), 2,628 lbs., and deflection, 0.24 in.

The Iscor Works in 1938

PLANT EXTENSIONS AND OUTPUT DURING THE YEAR

THE Iscor Works of the South African Iron & Steel Industrial Corporation, Limited, situated at Pretoria West, were operating to capacity during 1938, states the Annual Report of the Government Mining Engineer of the Union of South Africa, for the year to December 31 last. Various additions and alterations to the plant (excluding mines and quarries) were completed during the year as follow.

The erection of tar emulsion plant and tarphalte storage tank at coke ovens; the provision of an electrifying grab crane, construction of launder from Theisen plant to cooling ponds, and additional water seal at blast-furnace gas bleeder on the blast-furnace plant; the erection of 20-ton open-hearth furnace, underground collectors for Wellman chargers, electrically-operated slides, and a cement gun for calcining plant in the steelworks centre; new motor-driven rollers, alteration to reheating furnace, extension to bloomyard, equipment at sheet bar transfer skid, and additional work on spray pipes on the heavy mill; the erection of Quast repeater at the light mills; extension to stockyard and additions and improvements to sheet works; the provision of a sand conditioning plant, a 5-ton weighbridge, and electric lifting blocks in the foundry, and various work in the traffic department, the workshops, etc.

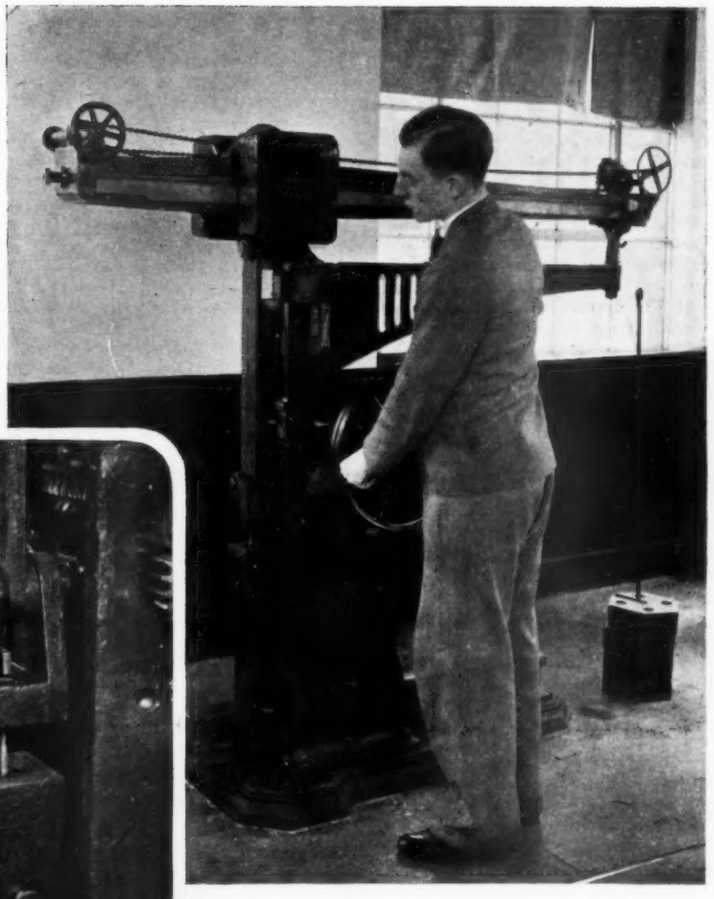
The various raw materials and fuel received by the Corporation during 1938 included 45,593 short tons of Natal coking coal, 24,168 tons of discard coal, 267,684 tons of washed Transvaal coal, 121,372 tons of raw Transvaal coal, 45,083 tons of purchased coke, 117,038 tons of dolomite, 70 tons of ferro-manganese, 150 tons of ferro-phosphorus, 305 tons of ferro-silicon, 868 tons of fluorspar, 48,866 tons of Marble Hall limestone, 25,129 tons of Taungs limestone, 49,558 tons of manganese ore, 23,161 tons of scrap, and 435,043 tons of Thabazimbi ore.

Production in 1938 included: At the coke ovens, 2,487,780 galls. of crude tar, 526,345 tons of crude benzol and substantial outputs of derived products. The blast furnaces produced 299,595 tons of pig-iron of all grades and the steel melting plants 330,201 tons of steel ingots. The output of the heavy mill was: Sections (angles, channels, joists, shaft guides, flats, flanges, welding rods, and rounds), 33,884 tons; rails and sleepers, 61,548 tons; blooms, 3,049 tons; light mill billets, 42,487 tons; other billets, 63,008 tons, and sheet bars, 59,696 tons. Light-mill products were: Rounds, 28,178 tons; flats, 3,884 tons; angles, 2,872 tons; wire rods, 1,117 tons; fencing standards, 1,142 tons. Sheet-works products were: Hard black sheets for galvanising, corrugated, etc., 35,748 tons, and plates, 12,328 tons.

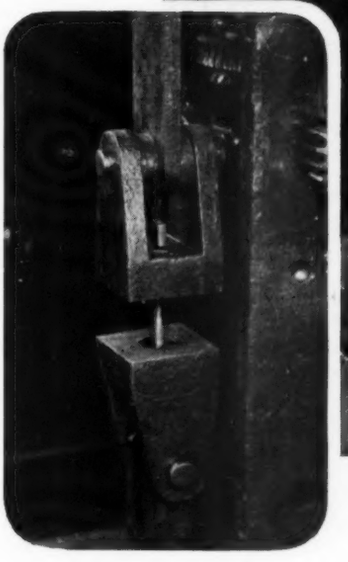
Catalogue Received

Moulding Machines.—A four-page leaflet received from W. J. Molineux (Foundry Equipment), Limited, of Bhyllis Lane, Wolverhampton, describes and illustrates a new line of hand-press, direct-draw moulding machines. The machine is made in two sizes (HT1 and HT2), carrying a 4-in. and a 5-in. pattern draw using 16½-in. and 20-in. (max.) wide boxes respectively.

GLANTON *for* TENSILES



Tensiles of 12-14 tons per sq. in. are regularly obtained on mixtures using Glanton as a basis.



Analysis

Graphitic Carbon %	Combined Carbon %	Total Carbon %	Silicon %	Sulphur %	Phos. %	Mang. %
3.35	0.35	3.7	2.0-3.5	.02-.04	0.5-0.75	0.7-1.0

Glanton can be confidently used for the general strengthening of all cupola mixtures at small cost. A series of mixtures using Glanton were made in an 18" Cupola to ascertain the strength which could be expected in the average foundry where high grade metal is required. Full particulars are available on application.

The Stanton Ironworks Company Limited, Near Nottingham

The largest producers of foundry pig iron for the free market in Great Britain.

Mill Room Practice*

By A. G. READ

Although much has been written on the subject of mill room practice, very little of it deals with the actual work of the mill room as a production part of the plant. Too often it is looked upon as simply the room where the enamels are ground, whereas the author believes that a great many of the so-called enamelling shop troubles cannot be cured by good mill room practice, but what is better, they can actually be prevented. For instance, in winter and early spring, quite a number of plants, especially those working on sheet iron, encounter trouble caused through rust spotting. The first reaction will be to ask what the mill room has to do with that.

"Free Water"

Assuming that one is working with an everyday milling formula for grinding, say, 100 lbs. of frit, it will read something like this: 100 lbs. frit; 5 lbs. clay; 3½ lbs. oxide; ¼ per cent. carbonate of magnesia, and 30 lbs. water. All practical enamellers realise that one can grind 100 lbs. of frit with 30 lbs. of water, but very little of the enamel can be got out of the mill, so what is the procedure? The mill is allowed to run until the grinding is nearly completed, and then, say, 5 lbs. of water is added; the mill is run for a short time, then the enamel can be run out. Even then it is almost certain that the operator will have to add more water before the enamel is at the correct viscosity for use. For want of a better term this added water will be called "free water,' because it is not ground into the frit, but only mixed with it. It is this "free water" which, if it does not actually cause rust spotting, greatly aggravates it.

The author has been carrying out experiments to decide whether it is possible for the mill room to help to overcome this trouble, and it has been found that by putting all the water necessary into the mill at the start, and grinding the whole of it into the frit (thereby eliminating the "free water") the amount of rust spotting is definitely minimised.

There is the obvious objection which could be raised against the extra time required for the grinding, which it is freely admitted will be necessary, but surely it will be more economical to run a mill for an hour or two longer than usual, than have to remove, or recoat, quantities of work because of rust spotting? Of course, there are other ways of preventing rust spotting, such as the use of nitrate of soda, etc., but no enameller puts additions into a mill because he likes it, and the fewer additions one makes the less trouble one is likely to have in production.

Effect of Locality

During the past seven or eight years the author has started up a number of mill rooms in different parts of England and in Scotland, and he has had the privilege of visiting many others, and some of the things seen to be taking place have been more than passing strange. The one fact that stands out above all others is the way in which the same frits will perform in different plants. Thus, by taking a recommended milling formula and grinding exactly to the instructions, it will be possible to get quite good results in one plant, whilst the same frit and instructions will give results far from satisfactory in another plant. Obviously, numerous variables come into play, such as the difference in water, the speed of mills, the temperature in the shop, and so forth, but one of the most important is the furnace itself. It is important for the mill room to take the recommended milling formula simply as a guide, and to adjust not only the grinding fineness, but the viscosity as well to suit the plant.

Reclamation of Scrapings

One other direction in which the mill room can help in production is the method of handling scrapings from the spraying booths. Different plants have different ways of using up their scrapings. One plant will do first-coat work with all scrapings and use only new enamel for second-coat work, whilst another plant will mix new enamel and scrapings together and use the mixture for both first-coat and second-coat work. Everything depends upon the type of work and colour of the jobs being processed. On one job the management were able to get up to a mixture of 60 per cent. scrapings and 40 per cent. new enamel and turn out really good-class work with it.

The mill room practice, however, needs to be very thorough, and it was found that the best results could be obtained by taking the scrapings from the spraying booths before they became dry, putting them into a bin and letting them soak. Later the water is taken off the top and the material is sieved before putting it into the mill, lest there happens to be some tramp iron present.

It is a good plan to add a small percentage of clay in the mill; furthermore, it is essential to take fineness tests again. Scrapings seem to play extraordinary tricks with regard to fineness tests, but it can be asserted that if the operations are carried out properly by the mill room, they will help the production side of the plant to use up all the scrapings with the minimum of risk. Quite often using up scrapings is but little short of a gamble.

Poor Technique

One instance entering into the "passing strange" category refers to the mill room man who was loading a mill, into which he had to put 150 lbs. of frit. His way of doing this could hardly be called good mill room practice. He first of all emptied the whole of a bag of frit into the mill, taking it for granted that it did contain 100 lbs., then the next bag he emptied into the mill and stopped when he thought of it, and weighed what was left in the bag. Another instance was the case of a mill room with the mills mounted on concrete, but no platform at the back to enable the men to load the mills.

Type of Output and Frequency of Defects

As may well be imagined, the author is frequently asked some strange questions. Recently a gentleman connected with the sheet industry in South Wales asked "Why is it that, in the vitreous enamelling industry connected with cooker and stove work, one hears so much about boiling and fish-scaling and all other kinds of enamelling troubles, whilst in the hollow-ware trade it is very rare one hears these things mentioned?"

The answer is really quite simple. If a flat sheet of, say, 18 gauge is being enamelled, some trouble may arise. If, however, a similar sheet be used and pressed into some shape or form, thereby opening the pores of the metal, which not only allows the enamel to grip the metal easily, but what is perhaps more important still, enables the heat to penetrate more evenly, owing to the shape of the article, than is possible on flat work, then it will be obvious why hollow-ware is a much simpler proposition than flat work when it comes to vitreous enamelling.

Available Raw Material

Another question frequently asked is the one about the various qualities of sheet for enamelling. There are several grades available, starting with C.A. (close annealed), P.C.A. (pickled, close annealed), and P.C.R.C.A. (pickled, cold rolled, close annealed), and finally ingot irons such as Armco, Lyco and so forth. C.A. material definitely puts the operator on "scratch"; it *can* be enamelled, but the shop conditions and mill room practice must be up to a high standard, otherwise there will be trouble. If P.C.A. be used, the operator has been given something of a start, and if P.C.R.C.A. be employed then the handicap is still further reduced, and so on until the Armco type of sheet is reached. By using such high-grade enamelling sheets one is given as much start as possible in the handicap, and this is one of the cases where the mill room can help with the production side of the plant by closely studying the fineness of grinding and the viscosity at which the enamels give the best results on any particular grade of sheet.

Mill Stoppers

Another item of interest in mill room practice was called to the author's attention in rather a strange way. It is well known how difficult it is sometimes to remove the grinding stop from a mill when particles of frit cause the stop to get tightly wedged in the mill, especially at the start of grinding. Happening to be in a plant when a mill had just been loaded, the author was astounded some time later to see the mill stopped and the stop lifted out without the slightest effort, the reason being that rubber instead of porcelain stops were used. The enameller (who by the way is one of the old school) stated that he had been trying for years to get the mill-making firms to adopt the idea, and only recently had he been successful; he was very enthusiastic about the rubber stop, and showed one that had been in use for some time; it showed no signs of wear at all, but what seemed more important was the fact that he claimed the life of the mill linings was doubled, because it is invariably at the mouth of the mill that wear begins to take effect first of all. Regarding the rubber coming into contact with the enamel, he said that there was no wearing away of the rubber, so how could there be any contamination of the enamel?

Fineness Tests on Milled Enamel

In a Paper written by Mr. Hansen, of America, the method described below is detailed:

Practically all screen tests are a variation of the following method. The enamel, as it comes from the mill, should be passed through a 30 to 40 mesh screen to remove any extremely coarse particles of unground frit, and 50 mls. of enamel then measured into a graduated glass cylinder. The fineness test is conducted by washing this amount of enamel through a 200-mesh flat screen, drying, tapping and weignihg the residues.

The clay and enamel fines should be washed through the sieve held under a stream of gently running water; care should be taken not to splash any of the enamel mixture out of the screen. When all the fines have been washed through, the residue and sieve should be thoroughly dried. They may be dried over a gas or electric hotplate, or a small gas stove such as is issued in the mill room for boiling borax solutions. The heat should not be so extreme as to melt the solder with which the wire screen is fastened to the brass frame of the sieve. If gas is used, the hotplate should be covered with a piece of sheet metal. It is well to raise the sieve about an inch above either a gas or an electric hotplate. This protects against the melting of the solder in the sieve, and also allows a slight circulation of air underneath and through the sieve, which will assist in drying the residue. The screen and residue may also be dried by placing under the fork of a box-type furnace, where the heat from the hot burning tools and ware will dry the material.

(*Continued on page* 174.)

* Paper read before the Northern Section of the Institute of Vitreous Enamellers, Mr. H. Whitaker presiding.

The Mass Production WHEELABRATOR

Reproduced by kind permission of the General Gas Appliances Ltd., Guide Bridge, Manchester, one of the large concerns now cleaning their flat castings with this Wheelabrator Conveyor Plant, prior to vitreous enamelling.

The conveyor type Airless Wheelabrator machine is breaking all time records in the cleaning of flat castings, such as gas stove sides, etc. It is especially successful in conjunction with mass production systems where roller conveyors, such as those illustrated, have been installed to feed the machine automatically and continuously. See one working on our Stand at Olympia next week, or write for particulars.

Sole manufacturers and suppliers in the British Empire (excluding Canada).

TILGHMAN'S PATENT SAND BLAST CO., LTD.

BROADHEATH, Nr. MANCHESTER.

Power and Electrode Consumption in Electric Furnaces

RECENT EXPERIENCE IN SWEDEN

THE principal items of cost in the manufacture of steel in the electric-arc furnace are those for electric power and electrodes. The power costs depend not only on the make-up of the furnace, but also on the conditions under which the furnace is run, including the metallurgical processes taking place in the furnace, its dimensions, and the rating of the converter furnishing the power. The relative importance and effects of these factors and how they are influenced are discussed by S. VON HOFSTEN in "Teknisk Tidschift," according to "Stahl und Eisen," in reference to observations made on a 14-ton and a 7-ton arc furnace and a coreless induction furnace of 4.5 tons capacity at the Sandviken steelworks in Sweden.

The 14-ton furnace works either as an ordinary melting furnace with one slag or as a refining furnace. With a cold charge, the furnace is run at the start on a low pressure of 154 volts owing to the surges occurring during melting; after this period of 10 to 15 min. the load is stepped up (Fig. 1*a*), being later reduced again towards the end of the melting period in order to conserve the roof. During refining, the load is further reduced after the required temperature has been reached. If slagging off is practised, as shown in Fig. 1*b*, interruptions are necessary for drawing off the slag. As melting proceeds, the load is gradually stepped down, similar conditions and practice obtaining with the 7-ton furnace (Fig. 1*c*). The loading of the 4.5-ton coreless induction furnace is shown in Fig. 1*d*, the first relating to a cold charge and the second to a liquid charge. Interruptions were necessary in slagging off to change or to await the results of analysis, etc. A higher load can be used with a cold charge than with a liquid charge, since with the latter the load must be reduced on attaining the required temperature.

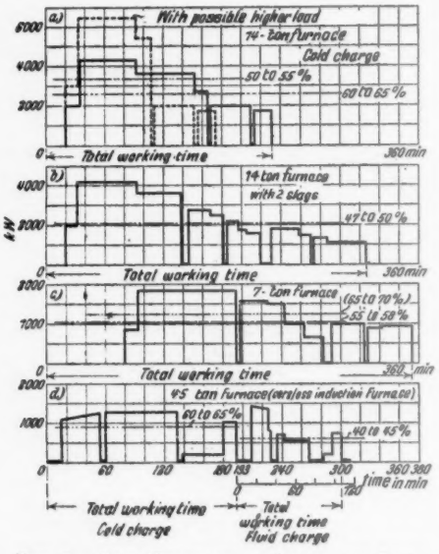


FIG. 1.—LOAD DIAGRAMS OF 14-TON AND 7-TON ARC FURNACES AND A 4.5-TON CORELESS INDUCTION FURNACE.

An indication of the factor of utilisation of a furnace is given by the ratio of the average load during the whole time the furnace is running to the maximum load, *i.e.*, by the load factor. The diagrams reproduced in Fig. 1 indicate that, when running the arc furnace using one slag, the load factor is 50 to 55 per cent., which compares favourably with the figures of 47 to 50 per cent. obtained with two slags. For the 7-ton furnace it is also shown how, with "basket charging," the load factor can be increased by reducing the idle time. This factor in the coreless induction furnace with a cold charge at 60 to 65 per cent. is particularly good, and could be further increased by reducing the time of waiting for analyses to be made. With a liquid charge, insufficient utilisation of the furnace in an electrical sense results. Reduced charging times, as may be achieved by mechanical means, *e.g.*, with a "basket," also enable a satisfactory load factor to be obtained.

In Fig. 2 the author shows the relationship between the output and the current intensity, indicating that both the total power input as well as the power of the arc pass through maximum values with increase in applied current at the electrodes, the maximum value for the arc being at lower currents than that of the total power. The curves, however, apply only to the 14-ton furnace operated under the conditions sketched above, *i.e.*, 220 volts and 10 per cent. damping. How the curves are altered as the conditions change is indicated by the two points marked with a circle and a cross, which apply to 154 volts and 30 per cent. damping.

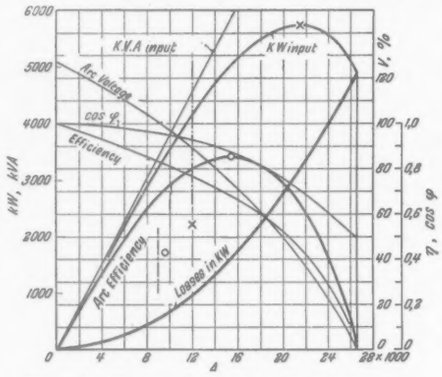


FIG. 2.—POWER VALUES OF A 14-TON ARC FURNACE PLOTTED AGAINST CURRENT VALUES.

The author then turns to a consideration of the most suitable electrode material, pointing out that amorphous carbon is no longer feasible for large furnaces. The only choice lies between graphite and Söderberg electrodes, depending, firstly, on which electrode works out cheaper per ton of steel made, and, secondly, which electrode exhibits the smaller liability to break. In the graphite electrode the joints are very sensitive to breakage, a disadvantage not present with Söderberg electrodes. But the latter as it can only take up one-fourth the current density possible with graphite electrodes, must be made larger than the latter, although not in a direct proportion, since graphite electrodes, in order to obtain the requisite mechanical strength, are usually made with much more liberal dimensions than required to carry the current density.

It is difficult to evaluate the actual consumption of electrode material when using either graphite or Söderberg electrodes; at Sandviken the ratio of Söderberg to graphite is usually taken as 1.8:1, while the ratio for carbon to graphite is 2.3:1. The absolute consumption of electrode material at Sandviken in the 14-ton furnace using Söderberg electrodes with a refining slag is 10 kg. per ton of steel, and in the 7-ton furnace with graphite electrodes 5.7 kg. per ton of steel. Another works gives 6 kg. per ton of steel for a 10- to 15-ton furnace. The lowest value encountered up to the present is 5 kg. per ton of steel. On working with one slag, the consumption with Söderberg electrodes is reduced to 6 kg. per ton and with graphite electrodes to 3.5 kg. per ton, while still another Swedish works gives 4.8 kg. per ton of steel with graphite. The Söderberg electrode would, therefore, be competitive if it cost half the graphite electrode.

Mill Room Practice.

(*Continued from page* 172.)

After the residue and sieve have been thoroughly dried, it is necessary to shake and tap the screen so that any material finer than 200 mesh may be sieved out. In the main this will consist of particles lodged in the meshes and held there by the moisture. This final sieving test can be best accomplished by a combination sliding and up-and-down tapping of the screen on the top of a table or any other convenient flat surface. This tapping and dry screening must be continued until no further material passes through.

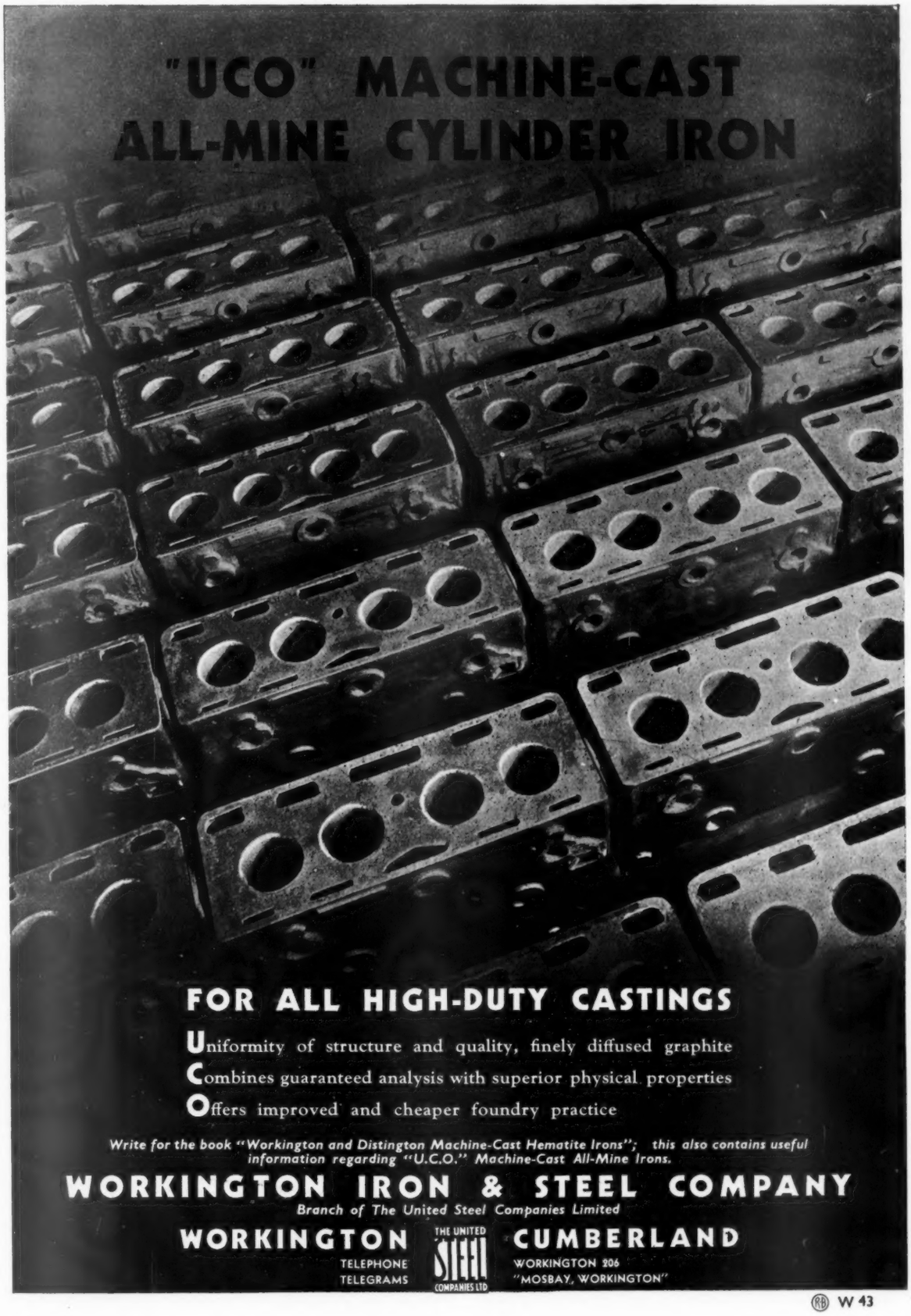
Another common and more satisfactory means of performing this sieving is by the use of a mechanical shaking machine. This method ensures the uniformity of the final sieving action and eliminates human error.

The final residue should be brushed down to one edge of the screen, and then tipped out into a piece of clean paper, from which it is transferred to the scales or balances for weighing.

The chief care to be used in the flat screen method is the care of the 200-mesh sieve itself. It must be remembered that a fine mesh sieve depends for its accuracy upon the size of openings between the woven bronze wires. A fine sieve naturally requires fine wires and these stretch in time—in a short time if the screen is roughly handled, changing the size of the openings. These fine wires are easily broken, and rather than throw away a valuable sieve soldering is resorted to—a practice which does not improve the value of the sieve. Enamel glass is forced between the wires, plugging some openings and warping adjoining ones. As a result after a few weeks of use in the mill room control the average size of the sieve openings has been changed and the results of tests may be several per cent. in error.

In the washing of enamel slips through screen and the subsequent drying operation, the meshes become choked with glass, which is difficult to remove, and, in drying, the solder often melts or otherwise deteriorates, giving rise to holes around the edges. It is good practice to use two screens in the process—a rather old one for washing the sample and drying it, and a newer screen for final dry screening. It is recommended that a standard screen be provided for checking purposes, and that all control sieves be checked at least once a week, either against the standard sieve or against a standard slip of known fineness. If the control sieve proves to be in error, a correction factor can be readily computed to bring the readings to the correct value.

At best, the fine mesh sieve is a delicate tool for use in an enamel shop. It is unfortunately, at present, the best test available, and must be used if fineness tests are to be run. Care must be exercised in maintaining an accurate check on the screens, and they must be handled with the thought in mind of the screen's weakness.


"UCO" MACHINE-CAST
ALL-MINE CYLINDER IRON
FOR ALL HIGH-DUTY CASTINGS
Uniformity of structure and quality, finely diffused graphite
Combines guaranteed analysis with superior physical properties
Offers improved and cheaper foundry practice
Write for the book "Workington and Distington Machine-Cast Hematite Irons"; this also contains useful information regarding "U.C.O." Machine-Cast All-Mine Irons.
WORKINGTON IRON & STEEL COMPANY
Branch of The United Steel Companies Limited
WORKINGTON
TELEPHONE
TELEGRAMS
THE UNITED STEEL COMPANIES LTD
CUMBERLAND
WORKINGTON 206
"MOSBAY, WORKINGTON"

(RD) W 43

The Week's News in Brief

Trade Talk

THE AUTUMN MEETING of the Iron and Steel Institute, which was to have been held in Cardiff from September 12 to 16, has been cancelled.

THE LONDON METAL EXCHANGE announce that they will probably hold a meeting every Thursday from 12 to 3 p.m. at the Northwick Park Hall, Kenton, Middlesex.

THE THREATENED STOPPAGE of work by employees in the foundry at Cowlairs Works of the L.N.E.R. at Springburn, Glasgow, was averted on August 29 by a settlement of a wage dispute involving moulding machine operators in the foundry.

FOR KEY MEN engaged in essential services and gatemen, the English Steel Corporation, Limited, Sheffield, have made cast-steel "pillbox" shelters with walls 1½ in. thick and capable of resisting bomb splinters, blast and falling *débris*. Each is designed to hold three men. These "pillboxes" supplement air raid shelters for 10,000 employees.

THE AMALGAMATED ENGINEERING UNION has agreed important step has been taken in an agreement between the union and the employers, which provides for the employment of an alternative class of worker on jobs where skilled men are not available. The shortage of skilled labour is admited, and the union has accepted dilution "in view of the international situation."

THE FEDERATION OF BRITISH INDUSTRIES intends to carry on the organisation in London, unless instructed by the Government to move elsewhere, and to keep in operation its district offices as long as possible. An announcement issued by Mr. Guy Locock, director of the F.B.I., adds that the Federation was formed during the last war in view of the clear need to have a central body to act for industry. The same will hold good if war should break out now.

THE ASSETS and goodwill of the Triumph Company, Limited, of Coventry, including the Gloria and Stoke works, have been acquired by Thos. W. Ward, Limited, of Sheffield. Manufacture of Triumph cars is being continued under the direction of Mr. Donald M. Healey, general manager. A further announcement will be made later as to the future programme. In June it was announced that a receiver had been appointed for the Triumph Company, Limited.

EDGAR ALLAN & COMPANY, LIMITED, of Imperial Steel Works, report that trade continues good, particularly on the export side, where substantial orders for super high speed steel twist drills, mining drill steel, permanent magnets, high speed steel, carbon steel, butt-welded tools, and similar materials, have been received. A further large order for locomotive steel castings has been received from an English firm, this contract, like its predecessor, running into five figures. Some important orders for electrical steel castings have also been received from electrical firms in this country. The machinery department of the firm, among numerous orders for individual machines and parts, has received an order for a large rotary furnace from a firm in the south of England and a complete crushing plant for South Africa.

Personal

MR. R. P. ADEANE has been elected chairman of Cochrane & Company, Annan, Limited, in place of the late Mr. C. E. Crompton.

MR. JOHN BOLTON, assistant secretary of the Institute of British Foundrymen, has been called up as a Territorial.

MR. ASHLEY SKELTON WARD, joint managing director of Thos. W. Ward, Limited, Sheffield, has been elected Master Cutler for the coming year. Mr. R. A. Balfour has been elected Senior Warden and Mr. S. E. Osborn, Junior Warden. Two of Mr. Ashley Ward's uncles have been Master Cutlers, the late Mr. T. W. Ward and Dr. Joseph Ward. It is a matter of regret that this year the historic Cutlers' Feast will not be held, for the function dates back several centuries.

Reports and Dividends

J. Brockhouse & Company (Ireland), Limited.—No dividend on the 6 per cent. preference shares.

Ransomes & Rapier, Limited.—Interim dividend of 2½ per cent., free of tax, on the ordinary shares.

Hale & Hale (Tipton), Limited.—Dividend on the ordinary shares of 5 per cent. for the year ended June 30 last.

Indian Iron & Steel Company, Limited.—Dividend of 15 per cent., free of Indian income-tax, for the year ended March 31 last—or one rupee eight annas per share of Rs. 10.

Brightside Foundry & Engineering Company, Limited.—Profit for the year to June 30 last, after depreciation and taxation, £137,000; brought in, £24,676; preference dividend, £2,500; dividend of 15 per cent., and a special bonus of 20 per cent., on the ordinary shares, £61,250; to staff pension fund, £2,000; to reserve, £65,000; carried forward, £30,927. Meeting, September 4.

Grovesend Steel & Tinplate Company, Limited.—Gross profit for year to April 1 last, £388,747; depreciation, £46,000; interest and other charges, £35,382; taxation, £45,000; net profit, £262,365; brought in, £99,056; dividends on investments in subsidiary companies, £68,424; written off value of investment in a subsidiary company, £46,608; dividend on the preference shares, £16,250; interim dividend of 5s. per ordinary share, £125,000; final dividend of 5s. per share, £125,000; carried forward, £116,987. Meeting, September 7.

Richard Thomas & Company, Limited.—Gross profit of the company and its controlled companies for the year to April 1 last, £1,159,235; Ebbw Vale works losses and running in expenses, £270,855; interest and other charges, £306,502; depreciation (including £50,000 in respect of the new Ebbw Vale works), £440,000; income tax and N.D.C., £77,067; net profits of controlled companies apportionable to shares held outside the group, £22,750; surplus for the year, £42,061. Gross profit of the parent company, £783,706; Ebbw Vale works losses and expenses, £270,855; interest and other charges, £224,386; depreciation (including £50,000 in respect of the new Ebbw Vale works), £278,258; credit arising on income tax and N.D.C. account, £10,000; profit for the year to be transferred to general reserve in accordance with the Articles of Association, £20,207. Meeting, September 8.

Contracts Open

Bagdad, September 16.—Cast-iron or steel pipes, for the Bagdad District Water Board. (D.O.T. reference T. 26,400/39.)

Durham, September 20.—Provision and laying of about 50 yds. of 9 in. sanitary pipes, 600 yds. of 4 in. cast-iron pumping main, etc., for the Rural District Council. Taylor & Wallin, engineers, 1, Saville Place, Newcastle-upon-Tyne. (Fee £5, returnable.

Johannesburg, November 13.—Pig-iron, ferro-manganese and ferro-silicon, for the South African Railways and Harbours Administration. (D.O.T. reference: T. 26,463/39.)

Montevideo, September 25.—100 tons of foundry pig-iron, for the State Electricity Supply and Telephones Administration. (D.O.T. reference T.Y. 26,387/39.)

New Companies

Avon Diecasting Company, Limited.—Capital, £10,000. Subscriber: C. P. Edwards, 21, Flint Green Road, Acocks Green, Birmingham.

Britannic Alloys, Limited, 14, Paternoster Row, London, E.C.4.—Capital, £8,000. Metal and alloy makers and refiners, ironfounders, etc. Directors: R. Hiscock and G. Potter.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

508,835. BERGHAUS, B. Resistance, spot, or seam-welding process.

508,848. PHILLIPS, LIMITED, J. W. & C. J., and HAYLOCK, C. Fillets for use in making patterns for casting metals or other materials.

508,925. KEMP, P. Separation of the component parts of alloys or mixtures of metals.

509,024. I. G. FARBENINDUSTRIE AKT.-GES. Manufacture of iron or iron alloys.

509,168. SMITH, R. L. H. Hardness-testing machines.

509,171. PRESSED STEEL COMPANY, LIMITED, and BERRIMAN, A. E. Welding systems.

509,188. MANNESMANNROHREN-WERKE. Apparatus for expanding tubes.

509,190. DEUTSCHE EISENWERKE AKT.-GES. Centrifugal casting moulds.

509,221. FUNDITOR, LIMITED, STROBEL, A., and PAGE, H. G. Ingot-feeding apparatus for metal casting machines.

509,229. BOWLAND, A. Hot-blast stoves.

509,266. SHORTER PROCESS COMPANY, LIMITED, and SHORTER, A. E. Surface hardening of metal articles having details such as curved surfaces or curvilinear projections or indentations to be hardened.

509,302. WILD-BARFIELD ELECTRIC FURNACES, LIMITED, BARFIELD, E. P., and ORAM, J. E. Case-hardening of ferrous metals.

509,306. MEHTA, F. P. Dephosphorising of steel.

509,322. SHAW & SONS (SALFORD), LIMITED, J., and SHAW, J. B. Presses for pressing or drawing sheet metal or the like.

509,361. DEMAG AKT.-GES. Continuous rolling-mill for producing tubes.

509,404. MEHTA, F. P. Manufacture of steel and alloy steel.

509,442. BRASSERT & COMPANY, LIMITED, H. A. (Colclough, T. P.). Manufacture of steel.

509,456. WILLIAMS, W. P. (American Rolling Mill Company). Formation of metallic composite sheet stock by direct casting.

509,469. AURIOL, A., and AURIOL, A. Furnace for the reduction of metal from ore.

509,577. HUBBELL, J. P., and WEISBERG, L. Electro-galvanising process for depositing zinc coatings.

509,609. VEREINIGTE EDELSTAHL AKT.-GES. Producing tantalum carbide and niobium carbide, more particularly for the production of hard metal.

509,657. SIEMENS & HALSKE AKT.-GES. Alloys for permanent magnets.

509,670. SCHLOEMANN AKT.-GES. Rolling mills.

509,671. BRITISH THOMSON-HOUSTON COMPANY, LIMITED. Systems of electric spot-welding.

509,708. SCHLOEMANN AKT.-GES. Stretching apparatus for flanged and other profile sections.

509,780. ARMOUR, A. M., and METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED. Method of and apparatus for sorting ferro-magnetic articles according to their mechanical hardness.

509,811. DEMAG AKT.-GES. Rolling mills.

509,901. LAVINO & COMPANY, E. J. High melting-point silicate refractories.

509,944. BRASSERT & COMPANY, LIMITED, H. A., THOMSON, T., and LOBKOWITZ, G. B. Rolling-mills.

509,951. WORTHINGTON, W. Method and mill for hot-rolling strip metal.

509,964. SCIAKY, D. Electric spot-welding apparatus.

509,983. DEUTSCHE ROHRENWERKE AKT.-GES. Apparatus for producing constrictions on hollow metal bodies.

510,001. STEWARTS AND LLOYDS, LIMITED. Production of cup-shaped hollow bodies from metal billets.

510,094. SIEMENS & HALSKE AKT.-GES. Apparatus for magnetically testing workpieces, especially seam welds.

510,116. LINDE AIR PRODUCTS COMPANY. Electric welding apparatus.

510,154. HERAEUS-VACUUMSCHMELZE AKT.-GES., and ROHN, W. Alloys with enhanced mechanical properties at high temperatures.

JUST TRY

"Hazlehead"

GROUND GANISTER

Here is a Ganister of which we are really proud . . . It is mined from a new seam . . . We feel confident you will agree with us that it is of an exceptionally good quality . . . It can be ground to suit individual requirements and is blended with a specially selected plastic refractory clay.

Prompt delivery can be given . . . May we send you a free sample bag?

●

GENERAL REFRACTORIES LTD

Genefax House, Sheffield, 10.

TELEPHONE: 31113 (6 LINES). TELEGRAMS: "GENEFAX, SHEFFIELD."

OUR OTHER WELL-KNOWN GRADES OF GROUND GANISTER ARE SUPPLIED FROM:—

DEEPCAR • SHEFFIELD • WOLSINGHAM • BONNYBRIDGE • HIRWAUN.

Raw Material Markets

CONTROL OF SUPPLIES AND PRICES

The iron and steel industry is now under Government control, and licences are needed to secure supplies. Maximum prices have been established at the levels current in the industry. Control of certain non-ferrous metals has also been undertaken by the Ministry of Supply.

Sir Andrew Duncan, chairman of the British Iron and Steel Federation, has been appointed Controller of Iron and Steel, and Capt. O. Lyttelton has been appointed to a similar position with respect to lead, zinc, tin and copper. The Hon. G. Cunliffe has been appointed Controller of Aluminium.

Under the provision of the Defence Regulations, the Minister of Supply has established a control of the iron and steel industry. Licences are required to acquire iron and steel goods and certain raw materials, but provision is made for exemption, by notice, from the necessity to obtain a licence in favour of certain classes of purchasers and/or certain purposes. A notice is issued concurrently with the order providing for the exemption of the main classes of first priority users, namely, Government Departments, purchasers requiring goods for Civil Defence purposes, and railway, shipbuilding and coal-mining undertakings. Goods forming the subject of existing contracts are also exempt from licensing, but may be subject to certain priorities.

All purchasers of small quantities of goods (not exceeding 10 cwts.) and purchasers from stockholding merchants for urgent requirements (during a period of 14 days from the date of the order) are also exempt from licensing. No licences are required for dealing in scrap iron and steel, but a licence is required from the Export Licensing Department of the Board of Trade for the export of scrap iron and steel and for certain iron and steel goods.

Maximum prices are established for the principal iron and steel products. The prices scheduled are those current in the industry, and it is contemplated that they will remain unchanged until October 31 next.

The order is dated September 1, 1939.

Controlled Products

Products for which licences are required are as follow :—

Iron ore of all classes—containing not less than 15 per cent. iron; manganese ore; scrap iron and steel fit only for the recovery of metal and for reprocessing.

Ferro-alloys of all qualities, excluding ferro-alloys of tungsten, vanadium, molybdenum and chrome.

All iron and steel products of all qualities and categories of the following classes :—

Pig-iron;

Ingots; billets, blooms and slabs; tinplate and sheet bars; wire rods;

Plates, medium plates and sheets, coated and not coated;

Angles, channels, tees, joists, piling sections and other sectional material, whether fabricated or not;

Rounds, rods, squares, hexagons, flats and all other sections and shapes, black or bright;

Rails; sleepers, fishplates and sole plates;

Tinplates, terneplates, black plates and silver-finished plates;

Hoop and strip, hot or cold rolled;

Pipes, tubes and fittings however made;

Tyres, axles and wheels;

Castings, blocks for forgings and pressings, forgings, stampings and pressings;

Wire, plain, barbed, coated and uncoated, wire ropes, wire netting, wire staples, chain link and square-meshed fencing and wire strand, wire nails and screws;

Colliery arches and accessories and pit props;

Bolts and nuts, washers, spikes and rivets;

Structures, including bridge, pier, tank and plate work.

Priority Consumers

The products scheduled above may be supplied and received without restriction as to licence until further notice for use directly or indirectly for the following customers and/or purposes :—

Government Defence and other departments; local authorities for civil defence purposes; persons requiring supplies under the Civil Defence Act, 1939, or otherwise for air raid precautions;

Railway companies for repair and maintenance work; shipbuilders, ship repairers and marine engineers; collieries;

Persons having agreed prior to the date of the order to purchase any of the products scheduled, subject to priority being given by the suppliers to deliveries under the foregoing heads;

Persons purchasing from stockholding merchants out of their stock for urgent requirements during 14 days from September 1; and persons purchasing quantities of 10 cwts. or less.

Scrap iron and steel fit only for the recovery of metal or for reprocess may be supplied and received without restriction as to licence until further notice.

Non-Ferrous Metals

The control of supplies of copper, lead and zinc will be exercised by a Department of the Ministry of Supply entitled the Non-Ferrous Metal Control.

For the time being the purchase is prohibited of copper, lead and zinc for consumption except under licence. This restriction does not apply, however, to existing contracts in writing or to contracts for the purpose of enabling contracts with His Majesty's Government to be fulfilled, or to the purchase of copper, lead and zinc for the purpose of necessary repairs not requiring more than one ton of each metal.

The order also fixes maximum prices for copper, lead and zinc, and calls for a return of information from persons concerned in the non-ferrous metal trade of stocks of copper, lead and zinc and certain manufactures of these metals on forms which are being sent to the persons concerned.

Attention is drawn to the fact that the export of unwrought copper, unwrought lead and unwrought zinc and spelter and of non-ferrous scrap and old metal is being prohibited except under licence from the Export Licensing Department of the Board of Trade.

Control of aluminium will be exercised by a department of the Ministry of Supply entitled the "Aluminium Control." The order prohibits for the time being dealings in and deliveries of aluminium and aluminium alloys, whether virgin or secondary, except in fulfilment of Government contracts or existing written contracts; lays down maximum prices for aluminium, aluminium alloys and aluminium scrap; prohibits the disposal of aluminium scrap, except through authorised dealers and smelters; and requires returns of information in regard to aluminium and its manufactures.

Attention is drawn to the fact that the export of raw aluminium and aluminium scrap is prohibited except under licence from the Export Licensing Department of the Board of Trade.

Any person who carries on the business of a dealer in or smelter of aluminium scrap who wishes to obtain the necessary authorisation to continue such business should communicate with the Controller of Aluminium as soon as possible. A list of such authorised dealers and smelters will be issued in due course.

The provisions of the Order do not prevent a consumer of aluminium from re-melting the scrap produced in his own works for re-use in the same undertaking.

Attention is drawn to the fact that the conditions under which trading may be carried out are subject and without prejudice to all the powers of requisition. Such requisition, if made, would in no case be at prices exceeding those laid down in the order.

As soon as circumstances permit a further order will be issued under the terms of which consumers will be in a position to apply for licences to obtain aluminium to fulfil new contracts for essential civilian uses.

Temporary Maximum Prices

The Minister has suggested that the following temporary maximum prices for non-ferrous metals should be fixed. The prices are low and are liable to be adjusted from time to time.

Copper.—Electro wire bars, £51; best selected, £49 10s.; standard, £46.

Lead.—Empire £17 ex-ship, £17 12s. 6d. ex-warehouse. Foreign lead, duty for buyers' account, £16 12s. 6d.; ex-ship, £17 5s. ex-warehouse.

Zinc.—G.o.b. foreign, duty for buyers' account, £15 ex-ship, £15 12s. 6d. ex-warehouse. Empire zinc, including domestic, £17 5s. ex-ship, £17 17s. 6d. ex-warehouse. High-grade zinc, £18 ex-ship, £18 12s. 6d. ex-warehouse.

After the usual sessions of the London Metal Exchange last Thursday (August 31), it was announced that the Exchange would be closed until further notice. The Exchange accordingly remained closed on Friday, Monday and Tuesday, but a meeting was held on Wednesday, for one session only, for the purpose of levelling up positions to enable a clearing to be held to-day (Thursday). This clearing will govern all unsettled positions up to and including Wednesday, September 6, and the settlement price will be that fixed on August 31.

It was decided at Wednesday's meeting to hold one session daily in future, from 4 p.m. to 4.15 p.m., for dealings in tin only.

At a meeting of the International Tin Committee last Friday, it was decided to raise the tin quota by 15 per cent. to 60 per cent. of standard tonnages for the third and fourth quarters of this year.

Eire Iron and Steel Imports Order

The Eire Government has made an order under the Emergency Imposition of Duties Act, 1932, varying the duties on certain articles of iron and steel imposed by Section 16 of the Finance Act of 1938, by postponing until September 1, 1940, the date of coming into operation of the duty, except in so far as it applies to the following classes of goods, the duty on which is effective at once :—

Bars and sections of iron or steel not fabricated comprising: Rounds or rods (including rounds or rods twisted together), imported in coils or lengths whether straight or otherwise, $\frac{3}{16}$ in. to $1\frac{3}{8}$ in. in diameter inclusive.

Squares (including squares twisted together) imported in lengths, whether straight or otherwise, $\frac{1}{4}$ in. to $1\frac{1}{4}$ in., inclusive.

Flats imported in lengths, whether straight or otherwise, 1 in. by $\frac{3}{16}$ in. to 3 in. by 1 in., inclusive.

Equal angles, $\frac{3}{4}$ in. by $\frac{3}{4}$ in. to 2 in. by 2 in., inclusive.

Swiss Fuel Imports

Fuel imports of Switzerland in January to June last were considerably in advance of those in the parallel period of last year. Coal imports were 1,178,850 metric tons, against 864,746 tons, the principal sources of supply being France 266,509 (177,000) ons, Germany 452,200 (375,100) tons, and the United Kingdom 180,100 (134,400) tons. Coke imports improved from 379,315 tons to 471,611 tons, Germany supplying 292,574 tons against 237,470 tons in 1938, and France 81,865 tons against 54,301 tons. The averages prices per ton were slightly below those in 1938.

U.S. Steel Profits

The return on investment in the United States steel industry during the first half of 1939 was less than half the average return in the 10 years 1929-1938, and was only one-fifth as much as was earned in the 1919-1928 decade, according to the American Iron and Steel Institute. The industry's earnings during the half-year just closed represented 1.06 per cent. on capital investment, which compares with an average return of 2.4 per cent. annually over the decade 1929-1938, and with 5.1 per cent. in the 1919-1928 period. Net earnings of the industry after all charges, but before dividends, aggregated $25,450,000 for the half year. After payment of approximately $19,000,000 in cash dividends on preferred stock obligations, the net was reduced to $6,450,000. Approximately $55,000,000 in taxes were paid by the steel industry in the first half of this year, which was 20 per cent. larger than was paid in the corresponding period of 1938. The tax bill amounted to $3.70 for each ton of products shipped to customers of the industry during the half-year period. The total amount of dividends paid to the 519,000 stockholders of the industry represented 8 cents for each dollar going into the wages of the personnel employed by iron and steel producing companies.